SCHOOL SCIENCE

Vol. 8 Nos. 1 and 2

March-June 1970

In This Issue

[De]monstration of a method of levitation by [in]serting a piece of paper in the space between [a] special self-regulating electromagnet and a suspended tray of weights.

[N]A[TIONAL] COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

SCHOOL SCIENCE

QUARTERLY

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CONTENTS

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TO OUR CONTRIBUTORS

School Science is a quarterly journal intended to serve teachers and students in schools with the most recent developments in science and science methodology. It aims to serve as a forum for exchange of experience in science education and science projects.

Articles covering these aims and objectives are invited.

Manuscripts, including legends for illustrations, charts, graphs, etc., should be neatly typed, double spaced on uniformly sized paper, and sent to the Editor, School Science, Department of Science Education, NIE Buildings, Sri Aurobindo Marg, New Delhi 16. Each article may not normally exceed 10 typed pages.

The articles sent for publication should be exclusive for this journal. Digests of previously published articles modified to suit the scope and purpose of *School Science* will be accepted. In these cases the name of the journal in which the original article appeared must be stated.

Headings should not be underlined.

Selected references to literature arranged alphabetically according to the author's name may be given at the end of the article, wherever possible. Each reference should contain the name of the author (with initials), the title of the publication, the name of the publisher, the place of publication; the volume and page numbers.

In the text, the reference should be indicated by the author's name followed by the year of publication enclosed in brackets, *e.g.*, (Passow, 1962). When the author's name occurs in the text, the year of publication alone need be given in brackets, *e.g.*, Passow (1962).

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible ink. Photographs should be on glossy paper, at least of post-card size, and should be sent properly packed so as to avoid damage in transit.

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Letter to the Editor

In response to your invitation for "Comments and Suggestions" from readers of this journal, may I point out a few facts?

1. On your 'contents' page the sub-title 'Letter to the Editor" is conspicuous by its absence. Is it due to the fact that you do not receive any comments or criticism of the various articles or the lapse is inadvertent?
2. Though you are making an excellent effort to make the journal as broad-based as possible, the number of articles for Technical Schools are comparatively few. Authors of Text Books like "Elements of Mechanical Engineering" "Engineering Drawing" etc. may be asked to serialise their books for the benefit of science students.

Let me congratulate you on the excellent get-up of your journal and the preservable quality of the paper used in it.

Dr. L. D. AHUJA
I.I.T. New Delhi

Environmental Education—an Urgent Challenge to Mankind

DR. JAN ČEROVSKY

IN the recent years the total deterioration of human environment, in the first place of its natural component, became the most urgent, challenge of mankind being a question not only of its present and future economical, physical, mental and social welfare but also of its survival at all. This problem is clearly one of world-wide importance. The first necessary steps to make the human society aware of the totally unpleasant situation and to start immediate improvement has been undertaken by UNESCO (Biosphere Conference, Paris, September 1968, preparation for MAB international programme 'Man and Biosphere') and further ever by UN (agreement on UN Conference on Human Environment in 1972). The main reason to hold the UN Conference was expressed briefly but clearly 'because there is a world environment crisis' (UN last General Assembly, 3rd December 1968). A better, wise use of natural resources, landscape and the environment as a whole request a basic change of Man's relations towards nature. This is a matter of both practical and ideological approach. The modern 'Man's partnership with nature' has to be achieved through appropriate education emphasizing a real perspective ecological thinking. It has to reach all general public. It's tragic that ecological understanding is not a prerequisite for policy making (Prof. Laumont C. Cole in 'Canadian Audubon', 3015, Dec. 1968, p. 132).

It is necessary to influence the approach to the biological problems that surround us; every community has its difficulties with pollution, sewage disposal, the misuse of pesticides, neglect of parks, unnecessary deforestation and, of course, family planning (Kenneth V. Thimann in Bio-science' 18/12, Dec, 1968, p. 1101). The great challenge to mankind is an appeal for proper education.

In the same way in which the nature conservation movement began to make the public opinion conscious of the modern civilization's danger for the mankind by the impact on its natural environment, the conservation education was trying to seek and to outline the principles, methods and forms by which to create an up-to-date 'man's partnership with nature'. Since 1948 these educational activities are coordinated on a wide international scale by the permanent Commission on Education of the IUCN (International Union for Conservation of Nature and Natural Resources). Therefore because of one long-year experience I would like to explain briefly our main thoughts about the environmental education.

Paper presented at the Working Meeting on "Environmental Conversation Educations Problems in India", held at Dehra Dun in November, 1969.

What is 'Environmental Education'

There has been just a lot of research carried out during this century on the problems of change in the human environment and on the techniques for its design and management So there is the knowledge available, but the application of it is inadequate and slow. There is still insufficient public awareness of the relationship between Man and his environment, arising from inadequacies in our education systems. (Dr. T Pritchard in 'Biological Conservation 1/1, 1968 p. 27)

By 'Environmental Education' we understand all kind of education and information which aims at creating the correct approach of Man to his (natural) environment in the sense of conservation, wise use and management.

Although the 'Ecological thinking' is the basic feature of this correct approach and, consequently, of the environmental education, this education by far cannot be only a matter of science and specially biology teaching. Environmental education coincidently with the modern conservation of nature and natural resources and Landscape planning and management including not only scientific but also broader cultural, economical, hygienical, a esthetical and ethical aspects is an essential part of general civic, moral and liberal education. By its ideology it has to determine Man's philosophy concerning his relationship to nature and landscape as well as his role in the society living in this nature and landscape and using them as the basic component of its whole environment. As practical instruction it has to influence and even to form the correct Man's behaviour and acting in the wise use of his environment providing him with basic principles and rules of such behaviour and action. Facing the dangers of many-sided environmental pollution and deterioration in our modern world, this philosophy and rules of acting are of equal importance as the mental and physical hygiene, being in fact also a compound of it, because Man himself is the most valuable and at the same time the most powerful resource of the Biosphere.

Concept and Function of Environmental Education

A short concept of environmental education was compiled by the Education Commission of the Unesco Biosphere Conference It is presented in the following paragraph

(i) The critical problems of the biosphere urgently require the development of environmental education to form an attitude of man and his society towards the biosphere in the sense of wise rational use and conservation of the natural resources and the unity of the landscape

(ii) The basic principles of environmental education, interpreted according to possible levels and purposes, should be. to maintain and wherever possible to enhance the economic and social capital of the biosphere; to provide an integrated scientific approach to the planning, management and development of the environment as a unit in space and time;
to seek man's personal fulfilment in partnership with nature through and with natural forces: and to develop a policy of trusteeship for posterity.

(iii) Environmental education is required in different depths, according to the level of education being provided and the objectives being pursued, and should reach:

specialists in different occupations dealing with both biosphere management and education in order to fulfil effectively the principles set out above· adults in order to guide children and young people, to develop criteria by which they can judge policies and practices affecting their environment and, generally to enrich their lives; and

children and young people, as part of a scientific and liberal education, to enable them to enjoy the environment and use it wisely.

(iv) All available media should be employed in an integrated as well as as continuous and sustained programme of education and information about the environment. Each country should have a council, centre or similar institution for environmental education and these activities should be coordinated also on an international scale.'

The function of environmental education can be more readily seen and appreciated if the groups of people are considered who will make an impact on the environment and who have to be educated and trained properly in the light of their role in society (quoted from Dr. Pritchard's article on page 2 of this report):

(*i*) *Firstly* there are those who will embark on a career in the earth and life sciences, including biologists, geographers, geologists and agricultural and forest scientists, as well as farmers and foresters.

(*ii*) *Secondly*, there are those who, as planners, landscape designers, architects, civil engineers and the like, will deal with the design, construction, and control, of projects affecting the environment.

(*iii*) *Thirdly*, these are those destined to become physicists, chemists, and technologists, whose research and development work may severely affect the environment.

(*iv*) *Fourthly*, there will be the future statesmen, public servants, and other leaders who will locally, nationally, or internationally formulate policies and authorize actions having far-reaching effects on the environment.

(*v*) *The fifth group*, and probably the most important in the long term, will be those who, as the educationalists of the future will have the task of interpreting knowledge to young people.

(*vi*) The *last group*, includes those who, without any direct professional involvement should have sufficient interest to form a collective voice which will influence those in the previous categories.

System of Environmental Education

The environmental education, in order to be effective, has to be carried out as a united education system including both children and youth as well as adults, formal education at all levels (pre-school, primary and secondary schools, high-schools, colleges and universities, post-graduate studies), out-of-school education and activities and all sort of information, all this system to be well integrated within the general education systems. Environmental education has not to be considered as a specialized matter of science education only as it provides actually some quite important general educational benefit which shall be pointed out in the following paragraphs.

Environmental education at its present development stage does not exist as a necessary integrated, continuous and sustained programme. The elements of it occur in science, especially biology teaching, are developing at some universities (special chairs and institutes), within the activities of some youth and adults-voluntary organiza-

tions, promoted by some mass-media. In general however, there is a lack of proper integration.

However important it is to have an integrated environmental education system, there exist some items of it which deserve the highest priority This should be given to teachers and other educators training and further (post-graduate) education, to the role of ecology and creative conservation in university training of technologist (engineers), sociologists, economists and politicians and to the out-of-school education and activities of children and youth.

Pre-School level

From his first days, the formative young child has to make the first acquaintance with his environment, with other living organisms, earth, water, air, weather etc., and to learn how to enjoy and protect it. The education merely through the parents with increasing important role of kindergarten has to form a sensitive approach to the environment, its beauties and importance for Man Also the role of picture-magazines and TV should not be neglected.

More studies on children psychology, mental development and best educational methods are still needed. The effort of education at that age depend in the first place on the education of parents and on the training of creche and kindergarten staff.

Primary and Secondary School

The main 'environmental subject' at primary and secondary school levels is Nature History and Biology. In many countries environmental and conservation education at that level is being considered as one of the principal educational tasks of science and especially biology teaching. The approach and space given to environmental education in school-curricula and textbooks, however, usually does not correspond with the promoted importance of it and the less it corresponds with the actual needs The curricula and text books partly remain keeping the old systematic pattern overloaded with morphology and description of classes, families genus and species, partly try to be up-to-date by emphasizing genetics and molecular biology. Generally, they are neglecting ecology which is yet the principal means of environmental education.

There is an urgent need for revising the school-curricula and textbooks in science and especially biology teaching. Environmental education should penetrate all this teaching, illustrating by examples the applicability of science to the improvement of Man's life and through this approach at the same time giving a sound appreciation of science and better understanding of its principles.

In view of the broad interdisciplinary character of environmental science also the environmental education can embrace not only simple biology and earth science but also chemistry and physics, mathematics, history, arts and literature into which he has got to infiltrate. In many countries a quite good unity of approach is imaginatively taught at the primary-school level It appears much more difficult to maintain it at the secondary school level, where even biology frequently becomes separated into more specialized compartments. One of the principle necessary features of that united approach must be intended on overcoming the existing discrepancy between science and technology, between naturalists and engineers. Not only technology with its modern concerns, but also biology especially from the ecological aspect discovering the life cycles and chain of events and changes within the ecosystems, is a real adventure of discovery Both of them have today their

important role in design and management of the natural environment and aiming at this top goal of a harmonic, well-balanced, inhabited and wisely used and even created by Man landscape, do not have to get more and more controversial, but on the contrary they must cooperate

Besides new textbooks fully respecting and including principles of environmental education, there is an urgent need for all kind of other audio-visual teaching aids. Formal teaching in school has to be completed and supported by conducting simple experiments, field excursions and observations and other forms of semi-out-of-school and out-of-school educational activities (such as competitions, camps, expeditions etc.)

The key personalities in environmental education at this level are the teachers. Therefore the environmental education with a special view to its methodology has to be included in teacher training programmes as an obligatory course, more general one for primary school teachers and secondary school teachers in non-science subjects and quite a profound one for secondary school teachers in biology and earth science. The course should contain also field observations, studies and practical conservation training. Weekend and summer sessions, workshops, special lectures and courses, excursions, field studies etc. in environmental education for teachers should be organized within their post-graduate training.

High School and University Teaching and Training

There are quite many special technical high schools training engineering specialists of middle-rank qualification, such as agriculturalists, foresters, builders, geologists etc. The training programme is splited into specialized subjects (courses) which hardly give them any total survey on a correct approach to the environment as a unit and any proper respect of taking the environmental problems and interactions into consideration. Therefore, sociology has to be introduced as an obligatory subject in most schools of that type and level or at least given the utmost possible attention and care within other appropriate subjects.

During the last years environmental education developed in some countries by introduction of new courses, post-graduate study programmes, diploma and degrees in environmental science infilterating ecological thinking into other courses at least by some lectures, seminars and excursions, establishing special university chairs and institutes. This development should be encouraged emphasizing all the time the inter-disciplinary character of environmental education There is still a strong need for suitable teaching and training techniques, textbooks and audio-visual aids. Universities dealing with social sciences and publicity relations (adults education, out-of-school education, leisure-time use, journalism etc) should develop research projects on methodology of environmental education among the general public.

Out-of-School Education of Youth

In the dialogue between youth and adults, there are more and more questions emerging of bad approach of the past and present generation towards the environment (heavy criticism of pollution and deterioration of all kind, protest-songs concerning this subject etc,). Young people request immediate action, are ready to serve it and in many cases are developing its own initiative This should be encouraged and interest among broader masses of youngsters stimulated through:

(a) Support to all already existing youth clubs and societies specialized in environmental studies and activities (national and local young nature-friends, naturalists, scientists biologists, farmers, hikers etc , organizations) by funds and advise and establishing new ones of that pattern,

(b) introducing environmental studies and activities in a proper way into the programmes of other youth organizations, such as boy-scouts, girl-guides, young tourists, hikers, mountain-climbers, students, working youth, Christian and other religions countryside inhabitants, Red-Cross, etc., etc.,

(c) Giving proper publicity to environmental problems in youth journals, magazines and all other kind of literature, broadcast and TV programmes, using the suitable mass-media as organizers of these activities.

It is not difficult to awake interest in environmental problems among the young generation. It seems to be much more difficult to keep the interest developing by providing funds and tasks for real activities. Young people ask to be involved in concerte action which while improving their knowledge at the same time makes them useful on service for mankind They themselves wish even at their age to be able to take over their share in the general responsibility for human environment and not to be only instructed in a—what to them it seems to be-rather abstract and theoretical way on the environment. This can be reached through organizing studies, excursions, expeditions, camps, workshops and training seminars, work-camps like 'conservation corps', assistance at afforestation, different other landscape management and use, public-relations campaigns, etc., etc., not only on local and national, but also international levels, because of the high attractivity of international exchange and travelling possibilities for young people. The environmental studies and activities must become a real adventure to young people.

This out-of-school education of youth is of a great importance for the future and even present destiny and situation of our environment Its profit can be expressed in three main points:

(a) general education, i.e erecting of a correct relations of the future generation towards environment;

(b) search for and training of future well-advanced specialists in environmental studies and management of environment,

(c) immediate efforts in improvement of environment (working camps, conservation corps, youth research projects, information campaigns).

Further more, in this component of education we also find some very important general educational features These will be especially:

(a) Interesting and advantageous use of leisure by young people,

(b) education for self conducted devoted creative acting on service of the general public;

(c) through the international cooperation education for international mutual understanding and for peace

(Dr J. Gerovsky· International Youth Cooperation in Field of Nature Conservation. Paper presented at 'Vere in Naturschut zpark European Conservation Conference, Stuttgart, May, 1969).

The out-of-school environmental education of youth deserves a high degree of priority. It enables young people to act actually, it involves in the enthusiastic young generation not still infected by the older people's scepticism, the generation which will have to use and manage the environment wisely and at the same time enjoying it thoroughly.

Out-of-school Education of Adults

Out-of-school environmental education of adults is being provided by voluntary organisations and foundations which in some countries seem to play quite an important role They are organisations

(*a*) dealing with environmental studies and management as a whole,

(*b*) concerned with some special component of environmental studies and management (fishery, forestry, game, management, nature study, protection and conservation, gathering, planting trees and shrubs etc);

(*c*) paying some attention to environment within broader activities (tourists, hikers, technologists, writers, journalists etc., this group including also some very numerous and general bodies, such as trade-unions, youth associations and even political parties). All these educational activities and efforts are to be encouraged and developed.

A very broad and important field for environmental education has been opened by growing potential of working man's leisure time which quite a lot of people try to spent in nature. The many sided problems of recreation are becoming very urgent and topical ones at the present time It may be said that the modern member of the human society bored and tired both mentally and physically because of all the negative influence of urban and industrial explosion is seeking through recreation his new partnership with nature This is quite a valuable coin, but as usually a two-sided one, one side being the newly awaken man's interest in and understanding for the natural environment, the other one however a negative impact of man through recreational activities in his natural environment, especially vast and even small protected territories, beautiful natural areas, mountains and sea-shores. Therefore the environmental education has two main tasks and at the same time stages in this context:

(*a*) to prevent the damages caused to environment by people through their often even unconscious bad behaviour in nature and landscape during their recreation.

(*b*) to use the chance of people being for their recreation in the countryside in order to strengthen their knowledge of and understanding for natural environment and its needs.

All this education must be carried out in attractive and interesting ways presenting to general public the adventure of discovering knowledge, not annoying it by forbidding and boring instructions.

Information

All accessible mass-media, cultural and lecturing centres and clubs of adults' out-of-school education have to be used in the continuous and sustained programme of dissemination of information, knowledge and understanding concerning environment. These efforts should be aimed at creating a powerful public opinion on environmental problems which should be one of the most important means to influence all

those who actually decide and act in the management of our environment.

The Need for International Cooperation

It has become quite clear that the problems of environment have to be solved not only on national but also on world-wide level, because the environment is a matter of the whole mankind and it does not know any frontiers The environmental education is an international matter too, for this reason it must be coordinated internationally with much more intensive care than one usually given to international cooperation in other fields of education and sciences.

Science in the Sixties

BALKRISHNA KARUNAKAR NAYAR

WHAT are the more significant developments in Science during the last decade? This is a question for which no satisfactory answer can be given easily. Science is growing like an atomic mushroom. Scientific knowledge is said to double every decade. Lakhs of papers and reports are published each year, in English, Russian, and numerous other languages. It is impossible to pick up a handful and say these are the most significant.

Some of the discoveries and inventions of science are topical. They find immediate application. They catch the eye. Others lie hidden in the pages of obscure journals like Sleeping Princesses, awaiting some Prince charming to bring them into the limelight. Gregor Mendel's epoch making paper on the genetics of peas, published in an era when the volume of scientific research was very small, remained unnoticed and unappreciated for 35 years during a period when Darwin and his work on the Origin of Species were the sensations of the day Therefore, any broad assesment of the significant achievements of a current decade has necessarily to be selective, and to some extent blessed.

Moon Landing

The most sensational achievement of the past decade has been the stupendous feat of landing men on the moon—and bringing them back. It is a feat of such unimaginable complexity that even a top scientist like the Astronomer Royal of England had, as late as 1957, pooh-poohed the idea. "Space travel" he had snorted "is utter bilge" And yet in the matter of a dozen years, men have been to the moon twice, explored considerable stretches of the lunar land scape, set up experiments, brought back samples and even retrieved parts of a machine landed earlier. The landing of a projectile weighing several tons in a moving target four lakh kilometres away, within a few hundred metres of the intended spot, depended upon the coordinated performance of lakhs of human beings and millions of mechanical parts. The planning and execution of the Apollo project is itself a stupendous feat of scientific programming, of which the nearest example is the Manhattan Project for the production of the first atomic bomb.

The precision and accuracy of the various manoeuvres of the Apollo projects were achieved through the large scale application of computers. Computers are the intellectual counterparts of Alladin's mighty Djinns. Their ability to carry out thousands of operations in the twinkling of an eye, collect and evaluate data and use them according to directions is amazing.

Micro Electronics

The invention of the transistor 21 years ago marked the beginning of a technological revolution The ink-bottle size de Forrest radio valves with which we have been so long familiar were replaced by the toffee size

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transistor assemblies and the pistachio size diodes. These had paved the way for most of the sophisticated electronic marvels of the 1960's most notably the miniaturised high speed Computer. The last decade was characterised by the introduction of micro components no bigger than the kernel of a jira. Microminiaturisation has transformed the Computer from military, engineering and limited business tool to an important widely used device.

Micro electronic tools are being applied in many different areas of medicine. Tiny electro-mechanical devices are being developed as substitutes for human parts. Cardiac pacemakers have been designed which stimulate the failing heart muscles by means of electrical impulses. The action of artificial hands can be controlled by means of a computer modification of the normal electrical signals from the brain, directed to the upper stump of the arm. In the case of paraplegic patients who cannot control the action of the bladder, implantation of a miniature radio receiver with electrodes connected to the patient's bladder muscles makes it possible, by means of appropriate signals from on external transmitter, to contract and empty the bladder.

Advances in electronic instrumentation are leading to laboratory procedures and to automatic equipment for monitoring a patient's condition. By application of micro-electronics, a transmitter attached to a patient can send an electro-cardiogram by telephone to a central medical station for analysis. With the help of the communication satellite, it can even be transmitted to a specialist half way across the globe. A heart patient can in this way secure immediate advice. Electro-cardiograms from France, transmitted by communication satellite to a computer in Washington D.C for analysis returned the analysis to France in less than a minute.

The computer is also developing as a tool in the diagnosis and treatment of illness On being fed with data regarding clinical and pathological symptoms certain computers can give clear diagnosis or indicate additional data needed for a choice among possible alternatives Prescription by computer is only another step ahead

The communication satellite, or biting in an apparently stationary position 23,300 miles above the earth, is an instrument of unimaginable potential India has been hitched on to the international grid A communication satellite can easily become a "political pace-setter" for small nations even as the electronic cardiac pace-setter is to the individual. Once installed and put into operation, nothing can be done to make it ineffective except through the intervention of some one as effective as the one who planted it

The technological revolution in electronics, in which micro-electronics is playing a key role, will eventually affect education at all levels It will facilitate mass education by extending the capability of human educators. Each student can have access to the personal services of a well-informed tireless and responsive computer that acts as a tutor. The rate and style of teaching can be easily adjusted by the student to meet his individual needs and capabilities. Electronic teaching systems may not replace human teachers. They will make the teachers certainly more effective.

Magnetic Bubbles

A versatile new device conjured up recently may make current computers old fashioned, according to a report in the Time Weekly. When a strong enough magnetic field is applied to thin wafers of crystalline materials known as ortho-ferrites, com-

pounded of iron oxides and such rare-earth minerals as Ytterbium, Thulium, and Samarium-Terbium tiny cylinder shaped areas or bubbles of magnetism are formed in the wafer. Their polarity is opposite to that of the surrounding materials They are often smaller in diameter than a human hair. The magnetic bubbles can be maneuovered and positioned into an almost endless variety of patterns.

Since their presence or absence at specific points in the wafers can be precisely controlled, and electronically detected, these bubbles can be used to carry coded messages in the on-off binary language of the Computer, store reams of data and perform myriad mathematical calculations. Controlling the position of the bubbles is relatively simple One methods is to send small electric currents through tiny circuits rinted on the surface of the crystalline wafer. The currents generate magnetic fields that cause bubbles to form at predetermined locations in the wafer. Current passed through different branches of the printed circuits can form new bubbles, and move or erase existing bubbles. The same result can be achieved by the controlled motions of a magnetic field outside the crystal. This method eliminates the need for electrical connection to the wafer.

A thin crystal, only 110 of an inch square can carry 10,000 bits of information. Even the tiniest conventional computer circuitry is able to achieve only 10% of that density. In addition the crystals need just a fraction of the power required by ordinary computers. 15 million coded bits of information may be held in one or two cubic inches and run by 1/40000 watt. For the same job now world require a closet full of equipment and hundreds of watts.

Lasers

The developments in lasers have been remarkable. One of them involved techniques for the production and examination of pico second light pulses which last a millionth of a millionth of second. These pulses were obtained by using a light absorbing dye inside the neodymimum glass laser The dye is opaque at low intensities of light, but it becomes transparent at higher intensities. The transmission of light, therefore, is increased at high optical intensities Some lasers can emit pico-second pulses even in the absence of saturable absorbing dyes

One of the experiments set up on the moon by the Moon-Men was a 35 pound laser-ranging retroreflector to bounce back laser beams exactly parallel to the direction in which they arrive. The apparatus contained an array of 100 cylindrical cavities, each containing a cube-corner prism The experiment was intended to tell us the exact changes in distance between the earth and the moon.

One of the most outstanding events in mechanical engineering in recent years has been the development of the Rolamite. Rolamite has been hailed by some to be as basic a machine as the lever, wheel or inclined plane. The mechanism consists of two of more cylindrical rollers held tightly in the loops of an S-shaped band. The band may be made of any flexible material. In many applications, one end of the band will be attached to the top and the other end to the bottom of the inside of a box The band is then put under tension. This causes the band to "want" to flatten itself out. The tension also restrains the rollers from moving away from the band.

If the band is of the same width and thickness in the areas where it curves round the rollers, then the flattening out force is the same on both rollers. They then remain at rest. If by perforating, tapering or other means, the band around one of the rollers

is made weaker, then the balance will be upset and the stronger loop will cause the rollers to start rolling The mechanism will continue in motion until it runs into an obstacle or the force in the two loops again become equalised

The major advantage of the rolamite as compared to conventional ball and roller bearings is that it is almost frictionless. This is a particular advantage for operating in the near vacuum of space. The rolamite is likely to find application as a component in light switches, door hinges, pumps, pistons and thermostats. The inventor of the rolamite is Donald F. Wilkes, a mechanical engineer at the Sandia Corporation, U.S.A.

Conversion of Chemical Energy

Direct conversion of chemical energy into mechanical energy has been achieved by Aaron Katchalsky, an Israeli scientist. Scientists in Israel have apparently developed an engine that can translate chemical energy directly into mechanical energy The machine utilises bundles of fibres made of materials with large molecules. As they pass through different liquids, these fibres alternately lengthen and contract. If chains of these bundles are looped over pulleys while undergoing their expansion and contraction, they can turn a crank shaft. This new type of engine is expected to be used in the operation and control of delicate instruments in space craft and meteorological balloons

Nuclear Power

A series of nuclear-powered miniature generators have been developed, some of which are fuelled by pellets of Plutonium. One of a group called SNAP (System for Nuclear Auxiliary Power) has been in orbit aboard a navigational satellite for nearly a decade, yielding 27W of electricity to power a tiny radio transmitter Other isotope power sources have been built for space use in weather satellites and Lunar probes. One type has also been designed to heat the space suits of astronauts and the diving suits of deep-sea explorers.

A long lived nuclear cardiac pacemaker, sealed in plastic and implanted permanently inside the human body, may provide tiny rhythmic electric shocks to a diseased heart incapable of regulating its own rhythm

Nuclear reactors for propulsion in outer space are also being developed. They cannot be used for the initial take off because of the possible atmospheric contamination But they will be ideal for acceleration for long inter-planatary trips, or for ferrying transports between the moon and parking orbits near the earth.

Nuclear explosions a hundred times stronger than the blasts at Hiroshima and Nagasaki are now being put to peaceful purposes, under a programme called "Operation Plough-share" These explosions have been used for large scale earth moving excavations, and for opening up uneconomic mines. One of the explosions created a huge underground cavity, of several lakh cubic feet capacity, at a depth of a mile or so, to release underground gas resources economically. Over a trillion cubic feet of gas is expected A programme to dig a new Panama Canal, harbours in Alaska and Western Australia, a rail-road gap near California, etc., are in advanced stages of planning. Recent results show that the present series of deep titanic underground nuclear explosions may cause violent earth-tremors and even earth-quakes.

Under the Sea

Although the surface of the oceans occupy twice as much area as the land, we know less about the great bodies of water

than we know about the surface of the moon Today, Oceanography is one of the most important areas of development, both because of the intellectual challenge and the possibility of phenomenal returns. Investments in select areas of Oceanography are expected to yield 30% return per annum The construction of highly specialised underwater search and work craft is an exciting branch of ocean engineering which has sprung up in the past few years Small submarines called Cub-marines are available for about $3,000, the price of an Ambassador car. These crafts differ from the conventional submarines in that they are primarily designed to give the occupants a chance to see outside and to perform inspection tasks Other submersibles are fitted with remote hand (telechiric) devices for manipulating equipment and for retrieving sunken hardware. A H-bomb lost by the U S. Air Force off the coast of Spain was tracked down by two submersibles. The annual investment by U.S A. in Oceanography is about 500 million dollars.

Evidence has been produced in support of the theory of Continental drift, according to which the present continents formed one mass, with Africa fitting into South America, Europe into North America, with Australia and Antarectica coming together with India and East Africa. Definite proof has been obtained that the ocean floor is slowly spreading. During 1967, an international team of geologists found that rocks similar ages in West Africa and South America would form continuous belts if the continents were contiguous The annual drift is at present only 2 centimetres per year.

Spectacular and unexpected findings point to the reversal of the North and South Poles. Measurements since 1963 have shown that at various intervals between 100,000 and 1,000,000 years, the earth's North Pole becomes the South Pole and *vice versa.*

Water Problems

The problem of fresh water for drinking, industrial, and agricultural purposes is assuming alarming proportions A number of desalting plants have already been built up during the decade along many arid coastlines of the world Using fossil fuels like coal and oil, the cost is about 1 per 1,000 gallons. With nuclear powered desalinisation, the cost may be reduced to about 10 cents per 1,000 gallons. New techniques using membranes under pressure to separate salt from the water are being developed rapidly which will bring down the cost still further.

A new kind of water called "Polywater" was discovered by Russian scientists Derjaguin and Fedyakin in the early 1960's. Although it consists of 2 hydrogen and one oxygen atoms like ordinary water, it has a freezing point of—50 degrees C and a boiling point of about 500 degrees C The solidified polywater is more like glass than ice. Polywater is prepared by condensation of water vapour in quartz of pyrex capillary tubes with hair thin holes of about 10 micrometres. The capillaries are suspended over distilled water in an evacuated sealed system. After about 18 hours, the condensate in the tubes shows the characteristics of polymeric water Many questions about Polywater are unanswered yet. Polywater is very stable. But, why is it not 40 per cent more heavy than water. Does it exist at the bottom of the Oceans? Does it occur in the body? If so, what is its role in the life process?

Weather Modification

Intentional weather modification has grown into a science since 1963. There is increasing evidence that precipitation from

some types of clouds and storm systems can be modestly increased or redistributed by seeding techniques. In 1968, U.S.A. spent more than 7 million on efforts to produce rainfall alone, in addition to an equal amount on research into modification of hail, hurricanes, lighting and other aspects of weather

When man learns to modify weather, law will have to resolve disputes over who took whose clouds, brought rain when the complainant wanted sun, turned warmth into cold and so on. Already legal disputes have arisen in U.S.A. as a rsult of cloud seeding operations in New York State, and in Texas. When the manufacture of climate becomes a major industry, it will affect all of us so violently that international regulations will become imperative.

Photography can measure, explore, probe, see, remember, compare, penetrate, differentiate, examine, select and extend our vision. Just as a microscope allows man to expand a small area of space for more careful examination or measurement, the high-speed camera can magnify a small segment of time. Present-day technology enables exposures as short as several nanoseconds' (1/1,000,000,000, of a second) Just as the telescope compresses a large area of space so that it can be viewed and analysed more easily, the time lapse camera does the same with hours, month or years. Sequential images can now be taken at the rate of hundred million per second.

There are numerous techniques for recording temperature differentials by means of colour changes. This technique has proved invaluable in forest survey work and in detecting disease or blight of crops from satellite observations.

By using photography, man has been able to see and obtain images from inside of a blast furnace, from the inside of a man's stomach, and to record the condition of the retina within the eye. It is the photographic equipment in satellites that secured sensational details of the moon, and Mars. They have given us continuous reports of the world's cloud cover, or birth of hurricanes. Some space crafts have transmitted signals based upon images recorded by television scanners as analogue or digital symbols which have been reconstituted as photographic images both in black and white, and in colour. The sophisticated Lunar Orbiter recorded this information on photographic film while circling the moon at 7,245 kms per hour, developed the film, analysed the information, and transmitted it back to earth over 4,00,000 kilometres away. The photographs of Mars relayed during a fly-past were even more fantastic. Photographic techniques have been developed in such a way that slight changes in body tissues, brain, etc., can be studied by eliminating normal features common to a series of pictures.

Substitute Organs

A race towards organ replacement is under way. It follows two diverse paths—transplantation surgery and the engineering of artificial organs. Kidneys, lungs and even hearts have been successfully transplanted with the patients surviving for long periods. The epic case of Philip Blaiberg, a retired South African dentist who lived with a borrowed heart, fixed up by Dr. Christain Bernard is still fresh in the public mind. Various ethical and legal questions have arisen. What is the legality of the donor-recipient contract? The utility of parts from dead persons, the exact definition of death, the possibility of blackmarketing in organs, the identity of the made-over person, saleability of body parts are all ticklish questions.

Artificial organs have also come into use. A small compact dispersable kidney was developed by the University of Chicago in 1963, which permits the patients to clean their blood at home

Arthur Konberg with his colleagues successfully synthesized a fully infections viral DNA that directed the production of exact replices of itself and the synthesis of all the components of the completely infectious virus DNA is the master molecule of life

The elucidation and explanation of the genetic code has been one of the great achievements of the decade in which an Indian scientist Har Gobind Khorana, now an American, shared the Nobel prize. Khorana is the second scientist from India to get the award.

A sexual propagation has made great progress. A whole plant can now be grown from a single pollen cell without fertilisation Professor F C. Steward of Cornell scraped an unfertilised cell from the body of a carrot and placed it in a specially prepared nutrient bath containing among other things coconut milk. In this solution, the cells began dividing and ultimately a complete carrot was obtained with roots, flowers and seeds.

New experiments in the field of animal sciences have greatly added to our capacity to produce offsprings with desired characteristics in large numbers. It is possible to wash hundreds of egg cells out of the oviducts of a prize cow with special hormone preparations. These can then be implanted into the uterus of other poorer quality cows, which after artificial insemination carry the foetuses to term, finally giving birth to calves that really belong to the prize cows. In this way, an exceptional cow can be made to produce hundreds of offspring. This method may help barren woman also to bear children

A human ovum has been successfully fertilised and partially developed without the intervention of a human uterus. This opens up the nightmare possibility of factory production of human beings

Developments in the fields of medicine and pharmacology have greatly prolonged life and relieved suffering. The cancer producing virus is reported to have been isolated recently. The exploration of the intricate chemistry of the living cell is providing a new understanding of heredity, growth and aging A drug that stimulates the RNA formation is being tested for its ability to improve memory in animals and in elderly debilitated men and women. The result may be a pill to increase men's intellect.

Just as our knowledge of organic chemistry has enabled us to develop new materials, and new drugs to make life more convenient and more secure, so this new biological knowledge will undoubtedly assist man in controlling such problems as virus infection, certain auto-immune diseases such as rheumatrid arthritis, and it is to be hoped, even cancer and old age.

Development in Genetics and plant breeding have made possible a green revolution all over the world. Sparked off by the work on high yielding varieties by the Mexican scientist Borlaugh, newer and bitter varieties of cereals, pulses and other foodgrains with higher protein content, shorter growth, larger yield, greater resistance to drought and pests, etc., have all been produced during recent years. There has been a 40% increase in food production all over the world as a result of the green revolution.

Biological Time-Bomb

On the occasion of the Science Talent Awards in the United States this year, Professor Seaborg, the arch-priest of Nuclear physics, who was connected with the dis-

covery of element 105 this year, and of several other trans-Uranic elements earlier said that if he had to live his life again, he would choose biology and not physics Biology dominates the field today as physics did in the earlier decades. But the Biological Time-Bomb is yet to go off The great strides in molecular biology have so far made possible through spin off from research into solid state physics and astronomy.

The recent discovery of large clouds of water and formaldehyde molecules in addition to hydrogen and ammonia in space has given a new dimension to theories on the origin of life. It is no longer certain that molecules of life had their origin on the earth itself or that similar forms of life do not exist elsewhere in the starry firmament.

Pollution

Environmental pollution has assumed alarming proportion as a result of our technological progress. Our situation today resembles in many ways that which prevailed during the first phases of the industrial revolution. The development of industry at that time created new sources of wealth, but it also generated appalling living conditions, particularly in the mushrooming industrial cities. The creation of economic wealth during the industrial revolution was achieved at the cost of physical and mental degradation of immense numbers of human beings.

Water pollution as a result of disposal of raw sewage industrial effluents, agricultural chemicals, pesticides, etc , has reached a level at which the self-purification mechanism though bacteria has been irreversibly upset, through the reduction of oxygen and the spread of toxicity. All the world over, industrial wastes are killing off game fish, and slowly poisoning the entire living species

Air pollution is another spectre raised by the march of science. Smoke, industrial dusts, toxic gases, and radio-active wastes are slowly wearing down our insides Since such diseases do not become apparent until a long time after initial exposure, it is often difficult to relate the effect to the cause. It is well-established that chronic pulmonary disease now constitutes the largest single medical problem in the industrialised and highly polluted areas of northern Europe and even the industrial cities of the U.S.A.

Noise is another malaise. Steady intense noise inflicts irreversible damage on the nervous system of the ear American Courts already recognise its effect as an occupational disease and award compensation to workers whose hearing has been affected by exposure during work. It has been recently discovered that the heart-rate of the foetus can be accelerated by noises to which even the mother may have become tolerant. The implications of the increasing supersonic boom have yet to be studied. Fears have been expressed that the sonic boom may turn out to be the sonic doom

The ultimate long-term objective of environmental control is to manage society in such a manner that the products of its activities can be recycled so as to become useful again, instead of being wasted and added to environmental pollution. City garbage is being collected to make fertiliser through a biological process of composting. Dust from grain elevators is being made into pellets for cattle feed. Fly ash from smoke stacks is being collected for making bricks and cement Sulphur form oil refineries and sulphur dioxide from factory chimneys are being used as raw materials for the manufacture of sulphuric acid. Environmental improvements present problems that can be solved only by a new kind of science.

We have developed an immense amount of knowledge about matter, and powerful

techniques to exploit our environment. We have acquired much knowledge about the human body and some skill in correcting its effects and controlling its responses We are, however, letting scientific technology develop in a haphazard manner according to its own rules, instead of subordinating it to desirable human ends We are grossly ignorant of the consequences likely to result from thoughtless manipulation of the external world and of man's nature.

The progress of Social science has hardly kept pace with developments in sciences and engineering With the impending population explosion, the shortening of distance through technology and the increase in leisure, man's interaction with man is tremendously on the increase. The world has become a small place. If the Biological Time-Bomb is not to end in a holcoaust, Social Sciences have to play an increasingly important role I may not be my brother's keeper But, I have to be his neighbour, if I am not be his murderer.

Triangular Numbers and their Different Uses

J.M. SHARMA
Field Adviser (Maths)
Directorate of Education; Delhi Administration

STUDY of natural numbers has been fascinating mathematicians since ages and a branch known as Number theory has developed in the course of time. We shall here talk about triangular numbers.

You know that there are even numbers, odd numbers, prime numbers similarly there are square numbers, triangular numbers also. In fact, every number has its own peculiar characteristics. Many of these characteristics which we often ascribe to different numbers are due to early Greek mathematicians who were essentially geometers Many of them had spent considerale time in arranging dots in different geometrical shapes and counting them. The geometric representation of triangular numbers is shown in the following triangular concentration of dots which remind us of the arrangement in the windows of a grocer's shop in a market:

This arrangement is essentially triangular in shape and hence the name triangular numbers. Thus the numbers 1,3,6,10,15,21 form a series of triangular numbers so that

$$T_1 = 1$$
$$T_2 = 3 = 1+2$$
$$T_3 = 6 = 1+2+3$$
$$T_4 = 10 = 1+2+3+4$$
$$T_5 = 15 = 1+2+3+4+5$$
$$T_n = 1+2+3+4+ \ldots +n = n\frac{(n+1)}{2}$$

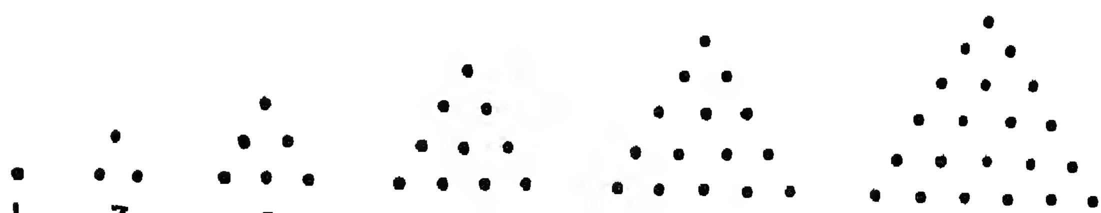
As you can see, T_n is the sum of the first n natural numbers.

The triangular numbers can also be shown on a single triangle as shown below in the following figure:—

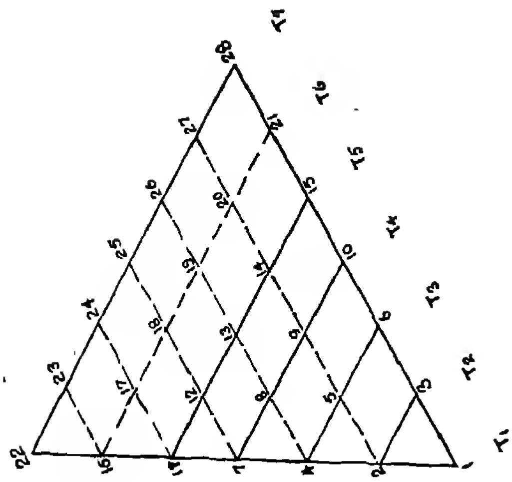
1	3	6	10	15	21	28
T_1	T_2	T_3	T_4	T_5	T_6	T_7

We see that by this arrangement all triangular numbers fall on the base line of

T_1 T_2 T_3 T_4 T_5 T_6



1 3 6 10 15 21



the above equilateral triangle. This pattern may be continued infinitely.

Some Properties of Triangular Numbers

(*i*) Sum of any two consecutive triangular numbers is a perfect square.

We see that $T_1+T_2=1+3=4=2^2$

$$T_2+T_3=3+6=9=3^2$$
$$T_3+T_4=6+10=16=4^2$$

$$T_n+T_{n+1}=\frac{n(n+1)}{2}+\frac{(n+1)(n+2)}{2}=(n+1)^2$$

The last equation explains the reason why the sum of two consecutive triangular numbers is a perfect square

(*ii*) $T_{m+n}=T_{n+m}n$ where m and n are any two natural numbers obviously $T_{m+n}=\frac{1}{2}(m+n)(m+n+1)$ and R.H.S.$=Tm+Tn+mn$

$$=\tfrac{1}{2}m(m+1)+\tfrac{1}{2}n(n+1)+mn$$
$$=\tfrac{1}{2}[m^2+m+n^2+n+2mn]$$
$$=\tfrac{1}{2}[m^2+n^2+2mn+m+n]$$
$$=\tfrac{1}{2}(m+n)^2[(m+n)]$$
$$=\tfrac{1}{2}(m+n)[(m+n+1)]$$
$$=\tfrac{1}{2}(m+n)(m+n+1)=\text{L.H.S.}$$

For $m=6;\ n=1$ $\quad T_7=T_6+T_1+6$

$m=2;\ n=3$ $\quad T_5=T_3+T_2+6$

From these we get $T_6+T_1-T_7=T_3+T_2-T_5$

With similar computations we can develop an unlimited set of relationships among triangular numbers.

We give below some more such relations.

(*a*) $T_2+T_4+T_5=T_7$

(*b*) Product of any two plus the third in the triangular numbers T_2, T_4, T_5 is also a triangular number.

(c) $T_2T_4+T_2T_5+T_4T_5$ is a square number 15^2;

(*d*) $2(T_2T_4+T_2T_5+T_4T_5)=T_2T_4T_5$

(iii) Another fact to be noted is that if a number IV is a triangular number then 8N+1 is a square number. Also for every square odd number from 9 onwards there exists a triangular number and to every triangular number there exists a square number. For example, for triangular number T_3 we have $8\ N+1=8.6+1=49=7^2$. On the other hand, consider a square number 25, say; $8N+1=25$ i.e., $N=3$ which shows that N is a triangular number. It will be interesting if you try this statement in general. Continuing with this concept we get, that some triangular numbers are also square numbers-though they are few in number. Here is a list of some of them:

1; 36; 1,225; 41, 616; 1,413, 721; 48,024,900; etc etc.

(iv) $1^3=1^2=(T_1)^2$

$$1^3+2^3=3^2=(T_2)^2$$
$$1^3+2^3+3^3=6^2=(T_3)^2$$

$$1^3+2^3+\ +n^3\left[\frac{n(n+1)}{2}\right]^2=(Tn)^2$$

We therefore make the statement :—"The sum of cubes of first n natural numbers is equal to

the square of the nth triangular number.''

(v) We know that $3^2+4^2=5^2$

i.e., we have the sum of the squares of the two consecutive numbers equal to the square of the next consecutive number. Can we find more such number relation in which the consecutive numbers alone are used. Let us consider the following equation:

$(n-1)^2+n^2+(n+1)^2=(n+2)^2+(n+3)^2$ i.e. the sum of the squares of the three consecutive numbers is equal to the sum of the squares of the next two consecutive numbers. Now for $n=11$, the above equation is true i.e

$$10^2+11^2+12^2=13^2+14^2$$

In this way we find,

$$21^2+22^2+23^2+24^2=25^2+26^2+27^2$$
$$36^2+37^2+38^2+39^2+40^2=41^2+42^2+43^2+44^2$$

From the above four numerical relations we note that only consecutive numbers have been used and the first number of the run is always a triangular number of even order i.e., of the form T_2n

$T_2=3$, $T_4=10$; $T_6=21$; $T_8=36$ etc.

we further note that the number of terms on the left hand, side is $n+1$ and on the right hand side is n. What a beautiful result;

(vi) Triangular numbers and the combinations:

Those acquainted with the notation of n_{c_r} know that $n_{c_r} = \dfrac{n!}{(n-r)!\, r!}$.

Now $T_1 = 1 = 2_{c_2}$

$T_2 = 3 = 3_{c_2}$

$T_3 = 6 = 4_{c_2}$

$T_9 = 45 = 10_{c_2}$

$T_n = \quad = n+1_{c_2}$

Now if we take numbers as the sum of the various triangular numbers, we can, have

$$1=1$$
$$1+3=4$$
$$1+3+6=10$$
$$1+3+6+10=20$$
$$1+3+6+10+15=35$$

All the numbers on the right 1,4,10,20,35,.. are found to be equal to the number of combinations of all these things taken 3 at a time

3_{c_3}	4_{c_3}	5_{c_3}	6_{c_3}	7_{c_3}	....
1	4	10	20	35	....

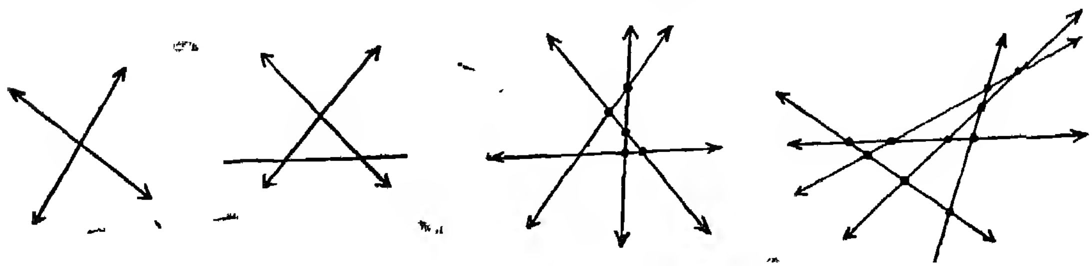
Now from these facts, it is clear that nc_8 can be expressed as the addition of terms of the form nc_3 e.g.;

$4c_3=2c_2+3c_2$

$7c_3=2c_2+3c_2+4c_2+5c_2+6c_2$ and so on.

What a nice relation do we get.

(vii) Triangular numbers and the points of intersection 1 of lines in a plane.



Now consider the problems of finding the maximum points of intersection of a given number of non parallel and non concurrent lines in a plane we will soon see how the triangular numbers come to our rescue here too?

From these figures we easily get the data as consolidated in the following table t

Lines	*Points of intersection*	*Triangular Number*
2	1	T
3	3 (=1+2)	T
4	6 (=1+2+3)	T
5	10 (=1+2+3+4)	T
6	?	?

We have set up the above table by actually counting the points of intersection from the above figures. Now what happens if there are six intersecting lines? If we closely scrutinise the column under the points of interesction' in the above table, the answer to the question we have just posed beames so very easy for we immediately discern that familiar pattern begins to emerge. We may conjecture that the next number will be T_5 i.e. 15. That this answer is correct can be seen, if we see what happens when each line is added to the existing set for it is the new line which brings the additional points of intersection with each of the lines already there, keeping the number of the existing points of intersections as unaltered. Start with two lines and take a third line. It crosses each of two lines already there and add no more points to the one already there. A fourth line crosses each of the three lines already there and therefore adds three (and only three) points of intersection. A new line must cut all the previous lines.

Table for Triangular Numbers

N	0	1	2	3	4	5	6	7	8	9
0	0	1	3	6	10	15	21	28	36	45
1	55	66	78	91	105	120	136	153	171	190
2	210	231	253	276	300	325	351	378	406	435
3	465	496	528	561	595	630	666	703	741	780
4	820	861	903	946	990	1,035	1,081	1,128	1,176	1,225
5	1,275	1,326	1,378	1,431	1,485	1,485	1,596	1,653	1,711	1,770
6	1,830	1,891	1,953	2,016	2,080	2,145	2,211	2,278	2,346	42,15
7	2,485	2,556	2,628	2,701	2,775	2,850	2,926	3,003	3,081	3,160
8	3,240	3,321	3,403	3,486	3,570	3,655	3,741	3,828	3,916	4,005
9	4,095	4,186	4,278	4,371	4,465	4,560	4,656	4,753	4,851	4,950
10	5,050	5,151	5,253	5,356	5,460	5,565	5,671	5,778	5,886	5,995
11	6,105	6,216	6,328	6,441	6,555	6,670	6,786	6,903	7,021	7,140
12	7,260	7,381	7,503	7,626	7,750	7,875	8,001	8,128	8,256	8,385
13	8,515	8,446	8,778	8,911	9,045	9,180	9,316	9,453	9,591	9,730
14	9,870	10,011	10,153	10,296	10,440	10,585	10,731	10,878	11,026	11,175
15	11,325	11,476	11,628	11,781	11,935	12,090	12,246	12,403	12,561	12,720
16	12,880	13,041	13,203	13,366	13,530	13,695	13,861	14,028	14,196	14,365
17	14,535	14,706	14,878	15,051	15,225	15,400	15,576	15,753	15,931	16,110
18	16,290	16,471	16,653	16,836	17,020	17,205	17,391	17,578	17,766	17,955
19	18,145	18,336	18,528	18,721	18,915	19,110	19,306	19,503	19,701	1,990

This is one general statement the nth line will cut (n—1) lines already there in (n—1) points of intersection. Hence n lines will have Tn—1 points of intersection.

If we change 'lines' to 'non——points' and "points of intersection" to lines in the foregoing discussion, we will note that exactly similar remarks which we made above, still hold good.

(viii) More fun with the Triangular Numbers

We have learnt above that $T_n + T_{n-1} = n^2$ and $mn = Tm+n - Tm - Tn$

We have already verified these relations algebraically. But with children perhaps it will be more useful to verify these by a numerical check. So for their benefit we append below a table upto T199.

How to use this table? Suppose we want to see T1—63 from this table, then we see 16 in the extreme left hand column and 3 in the top row, and just below number 3 to the right of 16 we see the number T163 = 13366. Now if we check 63 × 38 = T63+68—T63—T38 = T101—T63—T38 From Tables 5151—2016—741 = 5151—2757 = 2394 which is easily seen to be true

Triangular numbers, thus are not merely an idle mathematical curiosity but have certain properties which we have seen in this article They are indeed of great help and can be the starting point of several topics which we teach in one classroom. We conclude this article by one more remark *viz*: the coefficients of all the terms in the expansion $(1-x)^{-3}$ are also triangular numbers and as such these numbers must be also making their appearance in some oblique diagonal of the number pattern known as Pascal Triangle. This we leave to our readers to verify on their own.

Corrosion of Metal and its Control

(School Experiments)

PROF. S A. BALEZIN AND PROF. M. C. PANT

The destruction of metals under the influence of the environment e.g., of atmospheric oxygen and other gases contained in the atmosphere, of water, solutions of salts, acids and alkali as well as of electric currents is known as corrosion of metals.

Corrosion of metals is the process of regaining by metal its natural state i.e. the state in which it can be found in nature. The most common case of corrosion is the rusting of iron, its transformation into oxides and hydroxides

This type of loss due to corrosion of metals is called "direct loss". A rough estimate shows that as a result of corrosion about 10% of the metal produced in one year is irretrievably lost. For example, if a country produces or uses one hundred million tons of metal, the amount lost due to corrosion is roughly 10 million tons However, there occurs another type of loss due to corrosion, when as a result of corrosion, various machines, costly apparatuses, metallic constructions etc. are damaged and stop functioning. This loss is called "indirect loss" and its magnitude is much larger than that of direct loss.

Recent estimates show that in USA alone the total amount of the metal lost as a result of corrosion costs an enormous amount of 7 billion dollars annually. In other countries also more or less the same amount of loss occurs

It is due to these reasons that a knowledge of what causes corrosion and of the methods for protection of metals becomes of great importance not for its cognitive value but also for its vital practical importance

The experiments suggested here can easily be performed by pupils themselves even in schools with the least physical facilities of apparatus and chemicals.

Some of the experiments can be used by chemistry teachers as demonstrations.

Useful Corrosion

Corrosion of aluminium

On the surface of some metals one can find a firm oxide film which is formed as a result of the interaction between metal and the medium. This film protects the metal from further destruction.

Such films are particularly efficient when we have metals which are readily oxidised by atmospheric oxygen. One of such metals is aluminium. The oxide film formed on the surface of aluminium differs from those formed on other metals in this respect that, it is compact and impermeable. It cannot be seen with a naked eye since it is only 0 00001 cm. thick.

However, if we remove the film, aluminium becomes unprotected.

EXPERIMENT 1:

Requirements and Chemicals:

Aluminium wire, or plates, 50 ×2 ×10 mm

Beaker, 200 ml.
4% solution of NaOH
1% solution of $Hg_2(NO_3)_2.2H_2O$
Filter paper

An aluminium plate (or a piece of wire) is dipped for one or 2 minutes into a 4% solution of caustic soda dissolving the oxide film ($Al_2O_5+2NaOH=2\ NaAlO_2$). The salt $NaAlO_2$ that is formed is readily soluble in water. Next the plate is washed with water to remove the traces of salt and alkali. To prevent the formation of an oxide film the aluminium plate (wire) is dipped for one minute into a 1% solution of $Hg_2(NO_3)_2.2H_2O$*. Next the plate is washed with cold water and wiped dry with filter paper or a soft piece of cloth. The aluminium freed from the oxide film will within minutes start corroding with the formation of a loose mass of aluminium oxide. The reaction occurs with liberation of heat and the plate gets warmed up.

Aluminium unprotected by the oxide film interacts with water releasing hydrogen.

Artificial Preparation of Protective Film

EXPERIMENT 2:

Requirements and Chemicals.

2 nails or iron plates (steel), 50 ×2 ×10 mm
Sand paper, fine grain
3 beakers, 200 ml.
7-8 N nitric acid
10-12% sulphuric acid

Two small steel plates or two nails are cleaned with sand paper and rinsed with water. One of the samples is carefully put for 1-2 minutes into a 7-8 N solution of nitric acid.

Nitric acid is an oxidiser. On the surface of the steel a firm oxide or, as it is often said a passive film will be formed. The sample of the passivated steel is then washed with water Both samples—passivated and non-passivated, should be put into a 10-12% solution of sulphuric acid. It will be observed that the non-passivated sample will begin to dissolve with release of hydrogen where as the passivated sample will not dissolve.

The oxide film thus formed can be easily removed; if we touch with a copper wire the sample just removed from the solution, the oxide film will crawl down as drop (depassivation).

The depassivated sample, put into a solution of acids, will dissolve (Fig. 1)

Chemical Burnishing of Steel

EXPERIMENT 3:

Requirements and Chemicals

8 Steel plates, 50 × 2 × 10 mm.
Desiccator or beaker, 500 ml
Sand paper
Vaseline
5% solution of HCl
Caustic soda (NaOH)
Sodium nitrate ($NaNO_3$)
Sodium nitrite ($NaNO_2$)

Eight pieces of steel plates or nails are carefully cleaned with fine grain sand paper. Next they are rubbed with soft cloth till an even surface is formed. It is now to be cleaned further to make it free of fat. To achieve this the sample is immersed for 5-10 minutes in a 10-15% solution of alkali heated to 70-80°C. The samples are then washed with hot water. To completely remove the traces of the oxide film from the surface of metal, the sample is again immersed for 1-2 minutes in a 5% solution of hydrochloric acid and washed with cold water.

*Mercury and its compounds should be handled with caution since they are poisonous

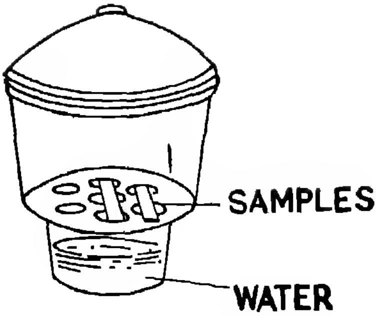


Fig. 2

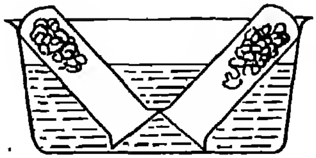


Fig. 3

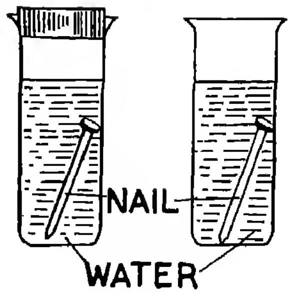


Fig. 4

put into each of the test tubes (fig 4). The test tube with the boiled water is now tightly stoppered with a cork to prevent dissolving of atmospheric oxygen in it. The rate of corrosion in each test tube is observed

EXPERIMENT 6 ·

Requirements and Chemicals : See Experiment 4.

A wire coil cleaned thoroughly with the sand paper is placed into two flasks of equal capacity (Freshly prepared iron shavings can be used instead of wire). One of the flasks is filled with oxygen and the other with hydrogen Both the filled flasks are tightly stoppered with corks fitted with delivery tubes, the ends of which are dipped into a beaker with coloured (for better visuality) water as shown in fig. 5.

It will take only a few hours to observe a rise in the level of water in the delivery tube connected with the flask containing oxygen and the appearance of rust on the surface of the wire.

Electro-Chemical Corrosion

Based on the mechanism of action involved, corrosion of metals is divided into two categories, one "chemical corrosion" and the other "electro-chemical corrosion". Chemicals corrosion is corrosion when metal interacts with a medium which does not conduct electricity. The reactions of oxidation and reduction which occur in this case are affected through a medium transfer of electrons from the atom of metal into the particle (molecule or atom)— oxidiser which is a composite part of the medium. The simplest example of chemical corrosion is interaction between metal and oxygen (particularly at high temperatures), halogens, hydrogen, sulphur gases, etc.

Electro-chemical corrosion is observed when oxidation—reduction processes take place in local areas where one area serves as the anode and the other as the cathode. In the anode areas the ions of the metal transfer into the solution while in the cathode areas the process of reduction takes place. Essentially electro-chemical corrosion is similar to what happens in galvanic cells. Most of the samples of metals used in technology contain impurities. In this case metallic spots serve as anodes while impurities as cathodes. Unlike in a galvanic cell, the cathode and anode in this case are short circuited.

When the metals are submerged into an electrolyte, say into a solution of an acid, the following process occurs:

On the anode:

$$Me + n2H_2O \longrightarrow Me(H_2O)n^{2+} + 2e^-$$

One the cathode:

$$2H^+ + 2e^- \longrightarrow H_2$$ where: Me = atom of Metal

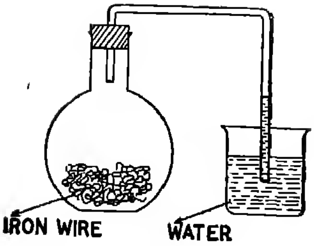


Fig. 5

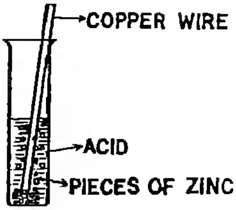


Fig. 6

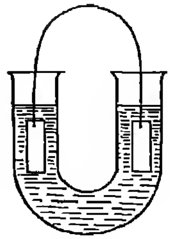


Fig. 7

Fig. 8

The copper rod is replaced in this by an iron nail round which is tightly wound some zinc wire. When the iron rod (nail) is immersed in the solution used in experiment 9, crimson colour appears on it (fig. 9).

EXPERIMENT 11·

Requirements and Chemicals : See Experiment 9

This experiment can be performed to detect the cathode and anode areas in the case of two metals which arein contact and undergoing corrosion. A solution 0·2 g of K_3 Fe $(CN)_6$ in 200 ml H_2O and a few drops (5-6) of phenolphthalein solution are added to a 2-3% solution of common salt (NaCl). In this solution is immersed a copper rod around which is wound some iron wire. In two to three minutes red colour will appear on the copper, while dark blue on the iron (fig. 10).

EXPERIMENT 12:

Requirements and Chemicals : See Experiments 9

On the surface of a steel plate is placed a drop of a 2-3% filtered solution of common salt (NaCl) to which a solution of indicator has been added The indicator can be prepared by adding 0-5 ml of a 1% solution of $K_3Fe(CN)_6$ and 5-6 drops of phenolphthalein solution to a 100 ml of the solution of NaCl. As the medium is neutral, on the cathode along the boundary of the drop there occurs the process of reduction of oxygen with the formation of hydroxyl ions. Thus at the boundary of the drop develops the crimson colour. At the anode, in the central part of the drop, where less oxygen penetrates, oxidation of iron takes place resulting in the formation of the ferrous ions (Fe^{2+}) When the ferrous ions (Fe^{2+}) interact with K_3 Fe $(CN)_6$ the blue colour appears at the anode (the centre of the drop). On the boundary between the cathode and anode there appears a brown ring of rust resulting from the interaction of the $F^{2+}2$ ions with the OH^- ions and subsequent oxidation of Fe $(OH)_2$ (fig 11.)

Protection of Metals against Corrosive Destruction

To protect metals against corrosion, various methods are used depending on the conditions in which the metal is going to be used.

These methods are: painting, coating one metal with another, electro-chemical protection and treatment of the medium by introducing substances (in the atmosphere, water, solutions of acids etc) which inhibit corrosion These substances are called inhibitors of corrosion.

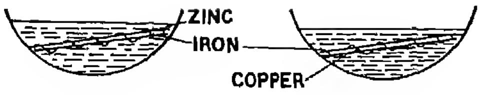


Fig. 9 Fig. 10

Electro-Chemical Control (protective-control)

EXPERIMENT 13:

Requirements and Chemicals·

Three 200 ml. beakers
4 steel plates, 60 ×40 mm., one coppei and one zinc plate of the same size

Two beakers containing 3% solution of sodium chloride are taken. Into the first beaker two steel plates connected with copper or aluminium wire are placed and into the other a zinc and a steel plate connected with each other in a similar way are placed.

In two-three days it will be observed that the steel plates have begun to corrode whereas the steel plate linked with the zinc plate will not develop corrosion for quite a long time till the zinc plate has dissolved completely

In this case zinc serves as anode and the steel plate as cathode.

Simultaneously one can perform another experiment by connecting the steel plate with a copper plate instead of the zinc plate. In this case the steel plate will soon begin to get covered with the products of rusting as in this case steel is anode and copper is cathode. (Fig. 12)

The above can be explained with reference to the normal redox potentials of these metals which are:

For $Zn/Zn^{2+} = -0.76$ V
For $Fe/Fe^{2+} = -0.47$ V
For $Cu/Cu^{2+} = +0\ 34$ V

Metallic Coatings

To protect metals from corrosion the process of coating one metal with another is often used To coat steel one has to use more corrosion resistant metals like gold, silver, copper, zinc, chromium, nickel etc.

One of the most widely used methods of coating is the galvanic method. Essentially, it is a creation of a galvanic cell, where the metal to be coated is cathode while the metal used as a material for coating is anode.

When a direct current is passed, the anode oxidises with the formation of ions and at the cathode these ions are discharged (reduced) forming a solid protective film:

anode: $Me \rightarrow Me^{+} + e^{-}$
cathode: $Me + e^{-} \rightarrow Me$

The galvanic method of coating is rather convenient as it enables one to obtain a layer of metal of a given thickness. As was stated above, gold, silver, chromium, nickel, copper and other metals are used for coating. Therefore, these coatings not only serve to protect the surface of the metal, but also improve the appearance of the main metal.

Galvanic Nickeling of a Copper Sample

EXPERIMENT 14:

Requirements and Chemicals:

One copper and 2 nickel plates, 60 ×40mm
Copper wire
Rechargeable battery
Rheostat
Ammeter
Bath for nickeling
Desiccator
10-12% solution of H_2SO_4
5% solution of HCl
Nickel sulphate ($NiSO_4$)
Boric acid (H_3BO_3)
Sodium chloride (N_aCl)

Before nickeling, the copper sample in the form of a plate 6 ×4 cm is immersed for

10 minutes in a 10-12% solution of sulphuric acid after which it is washed with water and cleaned with sand paper. The sample is then freed from grease using the same method as indicated in the previous experiment No. 3 and is immersed for one minute into a 5% solution of hydrochloric acid.

The following solution is used for nickeling:

(a) Nickel sulphate ($Ni\,SO_4$)—40 g
(b) Boric acid (H_3BO_3)—7 g
(c) Common salt (Nacl)—7 g
(d) Water—400 ml.

The solution is filtered and poured into a bath (glass jar) for nickeling.

A circuit is then made as indicated in fig. 13. The current density in this case must be 2-3 amperes per square decimeter.

The above solution is heated to 30°C and poured into the bath (1), (fig. 13). A battery (2) is used as a DC source and the sample to be coated with nickel (3) is immersed in the solution and connected with cathode while 2 nickel plates are connected to the anode (4). The current is switched on and its intensity is adjusted by means of a rheostat. After 5-10 minutes, the current is switched off and the sample is taken out of the bath and is already coated with nickel The sample is dried in the air and polished with soft cloth till it starts shining.

To check up the corrosion resistance, the sample coated with nickel and a sample that has not been coated are suspended in the desiccator on the bottom of which some hot water is placed.

The time necessary for each of the articles to start corroding is compared. The sample that has not been coated with nickel is the control sample

Chemical Coating with Silver

EXPERIMENT 15:

Requirement and Chemicals.

200-300 ml. beaker
10% solution of $AgNO_3$
10% solution of NaOH
20-25% solution of NH_3
10% solution of glucose

Steel or copper plates 60 × 40 mm in size

Along side galvanic coatings, chemical methods are also used especially for coating with silver.

For chemical silvering, the following solution is freshly prepared before the experiment. To 50 ml. of a 10% solution $AgNO_3$, is added a 10% solution of NaOH, until the formation of brown deposit of silver oxide stops. Now to this solution containing the deposit is added a 20-25% solution of ammonia (NH_4OH) until the deposit dissolves completely. An equal volume of 10% solution of glucose is now added to this solution.

The sample to be silvered (steel, copper or bronze) is immersed in the solution. The samples should be previously cleaned according to the methods described in the previous experiments It will be observed that the samples will quickly get covered with a layer of silver. These are now taken out of the solution, washed in cold water and wiped with a piece of flannel till they start shining.

Inhibitors of Corrosion of Metals

Metallic and lacquer coatings and electrochemical protection are not applicable in all cases, as for example, in storage of precision measuring devices and instruments. An often used method to protect them from rusting was to cover them with grease and various lubricants which are relatively easily

removed from the surface of metal However, these methods are labour consuming and are not very efficient.

Scientists have developed a new method of protection which essentially consists in adding substances slowing down corrosion of metals into the medium, where metals articles are stored

These substances are called inhibitors of corrosion. Inhibitors of corrosion are divided into:

(a) Inhibitors of acidic corrosion
(b) Inhibitors of corrosion in neutral aqueous solutions, water and alkali
(c) Inhibitors of atmospheric corrosion

Inhibitors are used in small amounts from 0.02 to 1 %. The essence of their action lies in their absorption on cathode and anode areas, thus disturbing the work of the micro-galvanic cells emerging on the surface of metal The method of their application are different, depending on the conditions.

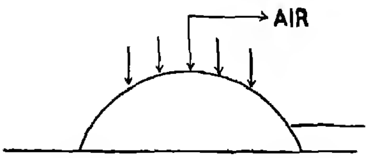
Inhibitors of Acidic Corrosion

EXPERIMENT 16

Requirements and Chemicals

2 burettes, 50 ml each
2 crystallizers
2-3 N solution of sulphuric acid
Urotropine (hexamethylenetetramine) and potassium iodide in powder form
2 funnels
Rubber inflator
2 steel plates 50 ×2 ×8 mm

Two arrangements are assembled as shown in fig 14.



Drop of aqueous solution of Nacl
Fig. 11

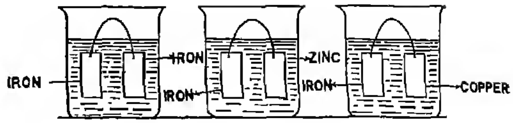


Fig. 12

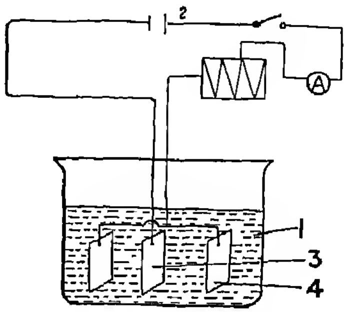


Fig. 13

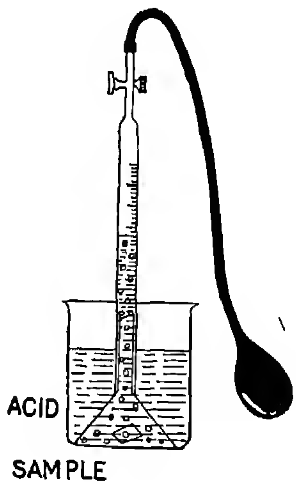


Fig. 14

The open end of the burette is placed on the funnel under which a steel plate is placed. 2-3N solution of sulphuric acid is poured into two beakers. Potassium iodide or urotropine (hexamethyanetetramine) which serve as corrosion inhibitors, is added to one of the beaker solution up to concentration of 0.5%. Then, with the burette stopper open,

the burettes with the funnels and samples under them are each placed into the two beakers. With the help of rubber tubing the burettes are filled with the solutions and the taps are closed. In the solution without the inhibitor, the burette will soon be filled with hydrogen released due to the dissolving of the metal whereas in the solution with the inhibitor, the burette process will be considerably slower. Measuring after one hour, the volume of hydrogen in both the burettes, the inhibiting effect is calculated (the coefficient of inhibition of corrosion by the inhibitor) by using the formula:

$$\text{Coeff} = 1 - \frac{V}{Vo}$$

Where Vo is the amount of the released hydrogen in the uninhibited acid, V is the amount of hydrogen in the acid with the inhibitor.

Inhibitor for Water

EXPERIMENT 17:

Requirement and Chemicals

- 2 beakers, 400 ml each
- 2 steel plates, 80 ×40 mm and 2 plates 50 ×20 mm each
- $(NH_4)_2CO_3$ and $NaNO_2$ in powder form
- 2 desiccators
- Filter paper
- Watch glass

Into two beakers containing 400-800 ml. of distilled or tap water are put two steel plates cleaned with sand paper (one may use iron nails) In one of the beakers is added as inhibitor about 0.5—0.7 g of a mixture of two salts $(NH_4)_2CO_3$ and $NaNO_2$ (1:1 weight ratio). On the next day corrosion will be observed in the beaker without the inhibitor . The experiment may continue for a year provided water is added up to the original level (see fig 15) to compensate for the loss due to evaporation.

Use of inhibited Paper

EXPERIMENT 18

Requirements and Chemicals See Experiment 17.

Saturated solution of a mixture of $(NH_4)_2CO_3$ and $NaNO_2$ (by weight 1.1) is prepared and filtered. Wrapping of newspaper or any other paper without glue is soaked in this solution and dried in the open The paper prepared in this way is called "inhibited paper" This paper is used to wrap up the samples which (as in previous experiments) should be previously cleaned and washed with distilled water. Similar samples (control samples) are wrapped up in uninhibited filter paper Hot water (to speed up corrosion) is poured on the bottom of two desiccators as shown in fig. 16.

In one of the desiccators the samples wrapped in inhibited paper are placed on the procelain disc while the sample with uninhibited paper are placed in the other desiccator. (Desiccators may be replaced by two beakers (500-800 ml) In this case the wrapped samples are wound with thread and suspended over the water. Every second month the samples are examined and compared.

Inhibitors of Atmospheric Corrosion

EXPERIMENT 19 .

Requirements and Chemicals: See Experiment 17.

On a watch-glass is taken a small amount of the two salts . $(NH_4)_2 CO_3$ and $NaNO_2$ (by weight 1:1).

The watch glass is placed in a desiccator or a breaker, on the bottom of which water

is poured so that it does not fall on the vessel with the salt mixture Two steel samples (in the form of plates) cleaned with sand paper are suspended over the vessel containing the mixture of the salts.

In the other desiccator (beaker with water) the control samples are suspended In three-four days the control samples will begin to corrode (fig 17).

The experiment should continue for a long time and the results should be observed from time to time, comparing the protected samples with the control samples.

Inhibitors and Stimulators

When such substances as inhibitors of corrosion are selected, it is necessary to take into account what metal is to be protected. Thus, for instance, salts of ammonium and organic amines are effective protectors of steel while they intensify (stimulate), rather than control, the corrosion of copper and its alloys. The potassium or sodium hydrogen sulphides protect zinc and aluminium in dilute solutions of alkalis, but they cause corrosion of silver, which under normal conditions, practically does not corrode.

The substances causing (stimulating) corrosion of metals are called stimulators of corrosion.

EXPERIMENT 20:

Requirements and Chemicals:

3 desiccators
2 copper and 2 steel plates, 50 ×20 mm.
Arrangement for preparation of chlorine
$(NH_4)_2CO_3$ in powder form.

Some water is taken in three desiccators or large size beakers (to create increased humidity) in order to speed up the corrosion process In each of them, as shown in fig. 17, two copper and two steel samples are suspended, (pre-treated with sand paper, till they shine). One of the desiccators is filled with ammonia gas. In place of gaseous ammonia, one can place in the desiccator a small beaker containing ammonium carbonate $(NH_4)_2CO_3$.

The second desiccator is filled with chlorine gas The third is control led with atmospheric air only. All the three desiccators (or beakers) are tightly closed.

It will take only a few hours to observe the corrosion of copper in the desiccator with ammonia and the corrosion of steel samples in the second and third desiccators It would thus be observed that ammonia is a stimulator of corrosion of copper, while it is an inhibitor of corrosion in respect of steel.

Conclusions

The experiments described above are simple to perform but some of them will take a long time before the final results are obtained. Therefore, part of experiments may better be performed with pupils as extra-curriculum activities, and the results of the experiments and observations can be used as demonstrational material.

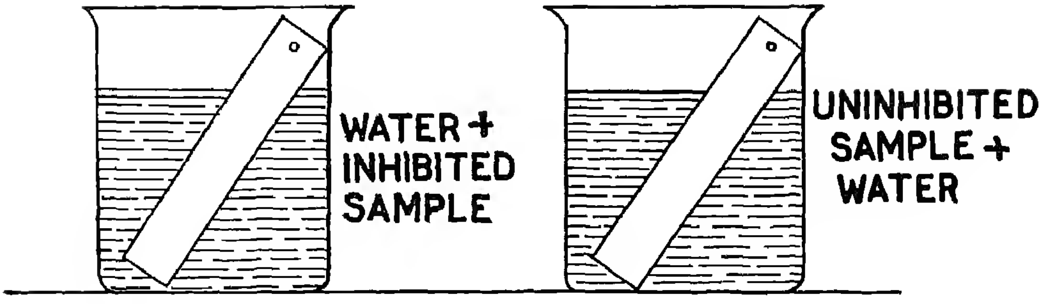


Fig 15

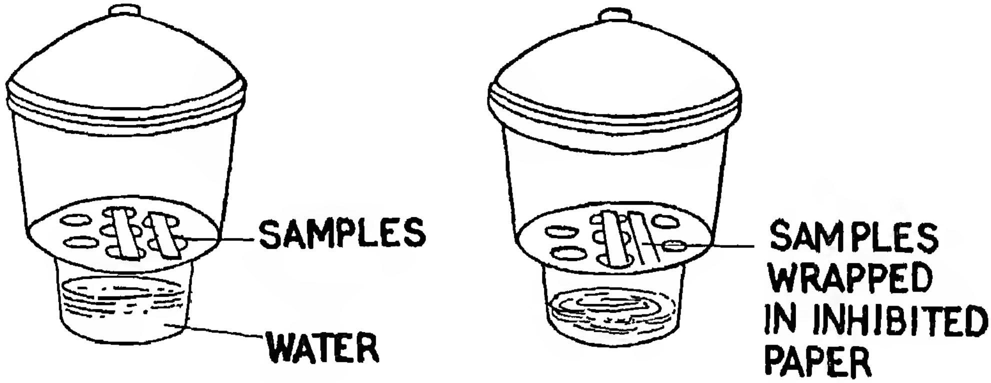


Fig. 16

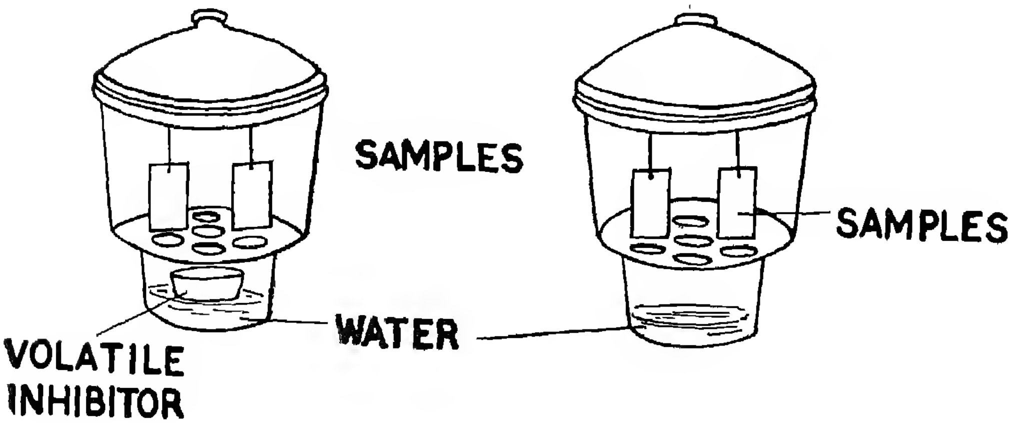


Fig 17

Inhibitors of Corrosion

PROF. S. A. BALEZIN

TO those who deal with metals this word is no less frightening than the ringing of the bells announcing a fire. As a matter of fact, this should be so: corrosion is the same process of burning only invisible to the eye. This invisible fire annually destroys upto 10% of the produced metals. But even this astounding figure fails to reflect the true scope of the loss. Corrosion destroys not just metal, it damages the articles already made the sophisticated shapes and precise measurements of which have been achieved with the consumption of a vast amount of labour. The cost of these articles is incomparably higher than the cost of the the metal involved. That is why the annual losses caused by corrosion add up even on the most rough estimate to an enormous sum of money—over 3½ billion roubles in the USSR and over 7.5 billion dollars in the United States. For centuries man has been seeking and is continuing to seek effective means of corrosion control. Once he had done it by intuition; today—by penetrating even more deeply into the nature of the chemical and physical mechanisms involved in corrosion. In most cases the corrosion of metal is a complex process in which purely chemical interaction is combined with electro-chemical phenomena. Accordingly, distinction is made between chemical and electro-chemical corrosion.

Chemical corrosion occurs when there is an interaction between the metal and a medium which does not conduct electric current Active substances present in the medium, e.g. oxygen, halogens or sulphurous gas cause the metal to interact with them chemically, electrons from the atoms of the metal being transferred immediately to the active particles of the oxidisers during such reactions (Scheme I). As a result, chemical compounds are formed which, as a rule, have inferior technical properties, and areas on the parts with such formations begin to distintegrate rapidly.

More often one has to deal in practical work with the second type of corrosion—electro-chemical corrosion. It occurs in the media capable of conducting electric current—in solutions of salts, acids and alkalies—and is governed by the laws of the galvanic cell. Pre-conditions for this are to be found in the commercial metal itself, as a rule, it is heterogenous and or contains foreign enclosures (impurities). These enclosures form with the main metal billions of microscopic pairs, the current conducting medium switches on the circuit and the galvanic cells start working (Scheme I, chart 2). At the same time the general chemical interaction consists of two largely independent, process is the anodic process in which case the metal itself passes into the solution in the form of positive ions, the cathodic process being accompanied by the "removal" of the excessive electrons from the particles enclosures—by the particles-depolarizers (e g. hydrogen ions) present in the solution.

Even this cursory acquaintance with the corrosion mechanism shows that the simplest

principle of protection of metals against destruction is isolating them from the environment This is the method used in many cases (metallic articles are coated with lacquers and paints, special protective coatings, polymeric films, lubricants and greases). But even such "protection" the creation of which is linked with certain technological difficulties often fails to save the metal, if the coating is damaged even in one place corrosion begins to eat the part at once. All this makes one to look for means of protection of metals from destruction simpler in use and more reliable in efficiency. Among such means belong substances known as inhibitors of corrosion

About a quarter of a century ago during the years of the great patriotic war, railway men of one of the railway station near Moscow witnessed an interesting experiment. At a distance from the main lines, on a dead end track there appeared a 25 ton cistern outwardly resembling hundreds of others. The railway men were looking at it with obvious suspicion: the cistern contained hydrochloric acid, the arch foe of metal: In the records of the railway transport there have many cases when hydrochloric acid was cause of railway accidents: it ate through the walls of the cisterns, found its way on to the track and damaged the rails. To prevent this, the walls of the cisterns made of metal were coated from the inside with natural rubber but even this costly coating did not completly ensure against unpleasant incidents: a microscopic failure in the rubber was sufficient for the process of destruction to begin instantaneously Now here on the dead-end railway track there had been kept for over 40 days a cistern without any coating, full of hydrochloric acid—and without any traces of damage.

It is difficult to say how long this experiment would have continued if the following had not happened. Another cistern with a rubber coating—suddently began to leak. There were not any similar containers for replacement readily available while the aggressive cargo was to be urgently delivered to one plant in Bashkiria. The acid had to be shipped in the experimental cistern Despite a long, severe shakings and long stoppages under the blazing sun—the experimental steel flask stood everything. Responsible for this was a small amount of the substance added to the acid. This substance named "Unikol" was one of the best inhibitors developed by Soviet Scientists The word 'inhibitor' can be traced to the Latin word 'inhibire' which means to slow down. Like catalysts accelerate the occurrence of chemical processes without, at the same time, entering into the final products of reactions, inhibitors slow down corrosive processes without actually affecting the 'properties of the aggressive medium. Therefore, they are sometimes called negative catalysts. The explanation of the hindering effect of inhibitors is in their particles forming on the parts rather peculiar protective films which insulate metal from environment. The mechanisms of the formation of the inhibiting films can vary. simplest of it is reduced to physical adsorption. particles of the inhibitor freely moving in the environment can approach the part and be caught here by the electrostatic field of the surface ion—atoms of the metal (scheme I chart A) forming a kind of a "fence" However, the "protection" thus formed has little resistance to heating—when the temperature rises the energy of the moving inhibitor particles become so great that the field of the ion—atoms can no longer retain them on the metal surface.

In this respect more stable is "protection" formed by the mechanism of chemical adsorption. In this case the particles of the inhi-

bitor located on the surface of an article interact with the metal itself after which they are retained in place owing to the more stable intramolecular bonds (Scheme I Chart B) In some cases the particles—combinations, thus formed, can diffuse—cross the boundary of the metal itself and pile up in close proximity to it. Inter-connected by the forces of inter-molecular interaction they form a protective film (Scheme I, chart C). This mechanism of formation of "protection" is called "Chemosorption".

A rather peculiar film is formed on the surface of metal also by colloid inhibitors Particles of colloids are known to bear on their surface electric charges preventing them from sticking to each other: as bodies having the same sign charge the particles are inter-repellant. On the other hand, having found themselves on the surface of the metal the particles loose their charges, begin to co-agulate (stick to one another) and as a result form a jelly-like film possessing protective properties (Scheme I, chart G).

Finally one must mention inhibitors which either cause the formation on the metal of a stable environment-resistant oxide film or solidify the loose film of the oxide already available. In the latter case the inhibitor particles penetrate into the pores of the loose film, "stitch" them and at the same time contract, as it were, the film itself—the thickness of the film diminishes while the film becomes more solid and impermeable (chart E).

It can be easily observed that in all the cases considered above the inhibitor interacts only with the surface of the metal, the area of which is as a rule comparatively small against the volume of the environment Therefore, to protect metals from corrosion, only a very small amount of inhibitor is required in most cases—from several tenths to one per cent of the weight of the substance in the environment.

To-day hundreds of various inhibitors are known. such a large variety of inhibitors were created not just because their developers wished so : unfortunately there are still no universal action inhibitors. Some of them suit, for instance, to control corrosion in acidic media but cannot protect metals from atmospheric corrosion; others perform well in atmospheric conditions but cannot work against acids Moreover acting in a certain medium as inhibitors the same substances may in other conditions enhance the processes of destruction of metal Therefore, inhibitors have a to be divid into groups with specific application and used taking into account both the peculiarities of the working medium and the metal itself.

In a large variety of contemporary inhibitors one of the main places belongs to inhibitors of acidic corrosion These are mostly inorganic compounds, nitrogen containing organic bases, aldehydes, alkalis, proteins, sulphur containing organic substances, some products of condensations of a aldehydes and amines. The greatest effect is, as a rule, produced by the inhibitors representing a mixture of several substances listed above An example of such inhibitors is a new preparation entitled BA6. It is a mixture of 5 parts of benziamine and one part of urotropine which if heated for two hours at 150°C turns into a viscous yellowish substances easily soluble in acids

Extremely good results have been achieved by using another new inhibitor of acidic corrosion *viz*, catapin. It is obtained as a result of the condensation of paradodecyl-benzochloride with piridine at 80°C for 8 hours. The end product *viz.*, paradodecyl benzo piride-chloride is the inhibitor catapin

Catapin readily dissolves in water and

solutions of acid It inhibits the dissolution of steel not only in hydrochloric but also in sulphuric and phosphorus acids The effect of catapin in sulphuric acid increases with the addition of potassium iodide to it. Depending on the amount of the admixture the rate of dissolution of steel in inhibited acid decreases 3,340-7000 times. At present catapin finds wide use as a means of protection of metal in oil extraction. The point is that oil, as a rule, is polluted with sulphur containing products Besides that, there is often a layer of water above the layer of oil deposits In this water various salts and gases are dissolved All this causes intensive corrosion of equipment which can be controlled by adding to the oil.

A special place among the means of corrosion control belongs to inhibitors in neutral media working predominantly in water and aqueous solutions of salts. These inhibitors are in most cases soluble phosphates and chromates out of which the most widely used are potassium bichromate K_2Cr_2O7, soda Na_2CO_3 and soluble glass Na_2SiO_3. Inhibitors of neutral media are used in the systems with closed cycles or, in other words, where the volume of the liquid remains constant or changes insignificantly.

To protect for a long time—for months and years—such metals as iron, copper and its alloys working in aqueous media, use is made of an inhibitor consisting of 1.5% sodium benzoate and 0.1% sodium nitrite (in relation to the weight of the working medium) This inhibitor can be used, e.g. to control the corrosion of motorcar water coolant radiators· it protects steel, brass and soldering at temperatures ranging from —25 to +100°C and can be added not only to water but also to anti-freeze liquids.

Inhibiting a liquid medium—acidic or neutral—is not particularly difficult: it is sufficient to dissolve in it the required amount of inhibitor More difficult is to protect metallic articles working in atmospheric conditions Here one has to think not only of the protective action of the inhibitor but also of how to "deliver" it on to the surface of the metal. Depending on the method of "delivery" inhibitors of atmospheric corrosion are divided into two large groups—volatile and non-volatile inhibitors. The latter in their turn are sub-divided, in accordance with the method of "delivery" into contact and crawling inhibitors As the name itself implies, contact inhibitors of atmospheric corrosion to which refer nitrites, chromates and bichromates, work only if they are applied immediately on to the area of the part that requires protection. In this regard more convenient are crawling inhibitors (sodium benzoate). Once this or a similar inhibitor is applied on to an area of the part to be protected it will start, because of the peculiar properties of its molecules and ions, to quickly spread over the entire surface covering it with a protective film. Non volatile inhibitors are usually applied on to the packing material with which the article is then well wrapped.

A much similar case is the use of volatile inhibitors of a atmospheric corrosion which, figuratively speaking, act "through space", e g., to protect an article from corrosion it is enough to pour a volatile inhibitor on to the bottom of a box in which it will be stored. An even greater effect is produced by anti-corrosion inhibited paper coming now into practice. Many must have already seen such paper: safety razor blades are wrapped with it, needles for sewing machines are sold packed in such paper and of course machine parts are packed in this paper. A razor blade or a needle seem to be just a trifle but by protecting them from corrosion the State saves millions of roubles. these trifles are

lems of which is the creation of universal inhibitors capable of protecting any metal from corrosion in any conditions The search for such inhibitors is going on During the testing of a number of inhibitors it was found that a mixture of ammonium carbonate and sodium nitrite protects several metals from corrosion equally well while delcyco-hexyl ammonium chromate protects such metals as steel, brass, pig iron and copper from destruction. All this supports the view that in principle the development of universal inhibitors is, possible.

'g' by Projectile Method

MANOHAR LAL
Science Teacher, Y D Inter College, Oel (Kheri) U.P.

THIS method is based on the principle of a projectile. Water is projected from a glass tube of narrow internal diameter This tube is fitted in a vertical plane making an angle α to the horizon. It is connected to a constant level water tank by means of a rubber tube Water is sent at constant pressure in this tube, so that it comes at constant velocity. After leaving the glass tube, the stream of water forms a parabolic path due to gravity. Its range is measured by a metre scale and initial velocity is calculated with the following relation.

We know that

$$R = \frac{u^2 \sin 2\alpha}{g} \quad \ldots\ldots\ldots (1)$$

Here R = Range on the horizontal plane.
u = Initial velocity of water (just leaving tube)
α = Angle of projection (slope of glass tube with the horizon)
g = Acceleration due to gravity.

Equation (1) can be written as

$$g = \frac{u^2 \sin 2\alpha}{R} \quad \ldots\ldots\ldots (2)$$

The value of g can also be calculated by measuring the maximum height H on the horizontal plane instead of measuring the range because we know that

$$H = \frac{u^2 \sin^2\alpha}{2g}$$

$$\therefore \; g = \frac{u^2 \sin^2\alpha}{2H} \quad \ldots\ldots \quad (2a)$$

Now suppose r be the radius of glass tube and Q is the volume of water collected per second. Then

The volume of water coming per second from the tube = volume of water collected per second

$$\pi r^2 \times u = Q$$

$$u = Q/\pi r^2$$

from this relation the initial velocity of water can be calculated. Substituting the value of u in equation (2),

$$g = \frac{(Q^2) \sin 2\alpha}{(\pi r^2)^2 \times R} \quad \ldots \quad (3)$$

First of all the value of 'g' was measured by this method. It was 979.7 cm/sec^2.

The apparatus used is shown in figure 1. A glass tube of internal diameter 0.325 cms. was taken. The smaller arm is about 2 cms The big arm is connected to a constant level water tank The small arm is fitted at an angle 45° to the horizon. This tube can be named as projecting tube. A meter scale is fitted horizontally in the level of projecting tube. Now water was sent in this tube at different velocities by adjusting constant level water tank at different height

The corresponding values of Q, determined by graduated cylinder and stop-watch Now Q^2 plotted was against R. The graph was a straight line passing through origin which is shown in figures 2 & 3.

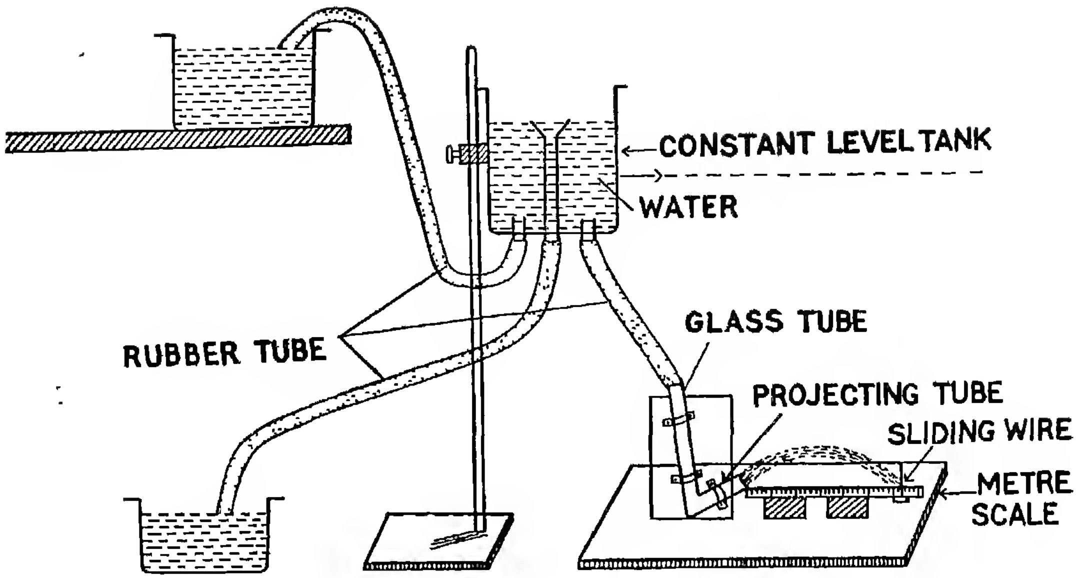


Fig. 1

Observations by discharging Water

Sl. No	Range R Cms	Time taken Seconds	Volume collected C Cs.	QC Cs/ Sec
1	7 3	40	280	7
2	11.5	40	357	8 925
3.	16 1	40	417	10 425
4.	19 3	40	457	11 425
5	22	40	485	12 125

S,.No	R Cms	Q^2
1	7 3	49.0
2.	11 5	79.6
3	16 1	108 6
4	19.3	130 5
5.	22 0	147 0

The value of 'g' can be calculated from the following relation with the help of graph in figure 2. For point 'A' in the graph. $Q^2 = 90$, $R = 13\ 33$ cms, $\sin 2\alpha = \sin 90 = 1$, $r = 0.1625$ cms, $\pi = 22/7$.

$$R = \frac{Q^2}{(\pi r^2)^2} \cdot 1/g \quad \therefore \; g = \frac{Q^2}{(\pi r^2)} \times 1/R$$

$$g = \frac{90}{(22/7)^2 \times (.1625)^4 \times 13\ 33}$$

$g = 979\ 7$ cms/Sec .

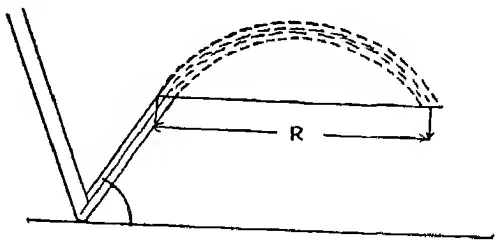


Fig. 2

Observations by Discharging NaCl Solution.

Similarly, observations were taken by discharging solution of NaCl through the glass tube at same constant angle 45 The heights of constant level water tank are same as in the case of water. In this case the corresponding value of Q and R are decreased due to increase of viscosity. The Q^2 vs. R graph is given in figure 3

The Liquid State I

L. D. AHUJA

Chemistry Department

I.I.T New Delhi

THE liquid state, of all the states of matter, is the least understood as for as its microscopic properties are concerned. Should we treat liquids as expanded solids or should we consider them as compressed gases is difficult to say The scientific understanding of the liquid state has lagged far behind the basic knowledge of both the solid and the gaseous state. The reason for this lag is to be found in the fact that liquids have neither the rigid geometrical structure of solids nor the complete randomness of gases Rather, they lie between these two states In fact they represent a peculiar compromise between order and disorder. The energy of a perfact gas is simply the sum of the energies of individual molecules—their internal energy plus their translational energy. There is no intermolecular potential energy. On the other hand, in the crystalline state, the translational kinetic energy is negligible. The molecules, atoms or ions vibrate about an equilibrium position to which they are held by strong intermolecular, interatomic or interionic forces. They cannot readily be treated either by the geometrical methods of classical crystallographers or the purely statistical methods used for gasses

Only in recent years have the theoretical and experimental techniques developed to the point where significant progress can be made towards a real understanding of the liquid state. But before we discuss any model or theory for the liquids, let us try to compare and contract their bulk properties with both of the other states which are almost completely understood now

Analogy with gases

(i) Liquids like gases are isotropic
(ii) Liquid readily flow under applied stress.

Analogy with solids·

(i) They both have a free surface
(ii) They both have property of cohesion.
(iii) Densities of liquids and solids differ only by 10-15%.
(vi) They both are compressible though the degree of compressibility varies somewhat.

Differences between liquids and solids can be explained by taking the analogy of heap versus pile: A pile is characterised by a unit cell, but not a heap. There is no way of predicting the position of the next particle in a heap and yet the density of a heap is fixed within close limits as any cereal merchant will tell you. The geometry of heap is determined only statistically. Density of a heap differs from that of a pile only by 5%.

Now the question arises, "Is it the similarities or the, differences which should be given the overall importance? Obviously it is a question of personal preference. One

good point in favour of liquids is that it is rather easier to correlate the physical properties of liquids among each other and with molecular structure because of the fact that far greater efforts have been spent on technologically more important liquids The second good point is the ability of the mobile molecules in the liquid state to acquire the highest packing density consistent with the ratio of their kinetic to potential energy. The substantial absence of steric resistance to close-packing removes what proved to be one of the major stumbling blocks to the predictability of the properties of crystals.

At present, there are three major schools of thought on the structure of liquids The leaders of these schools are Henry Eyrning-Dean of Graduate School, University of Utah (U S.A.); Joel Hilderbrand-Professor Emeritus, University of Californa, Berkley (U S.A.) and Stuart Rice-Professor of Chemistry and Director of the Institute for the study of metals, University of Chicago. Their views may be summarised as follows:

1. If we removed about every eighth molecule from a solid and then placed the remainder in rapid motion, we approximate the behaviour of a liquid (Eyring).

2 Thermal agitation imposes on molecules in a liquid, a state of maximum disorder; there is no trace of long range order, except for that imposed by their density and by the rule that no two molecules can occupy the same place simultaneously (Hilderbrand)

3. Why adhere to any pictorial model at all? Simply calculate some distribution functions for interactions among pairs and larger groups of molecules and use them in predicting the macroscopic properties

Let us elaborate these views one by one

Eyrings Fluid Vacancy Model

When a simple substance (like argon) melts, it expands by 12%. In spite of that expansion X-ray diffraction indicates that the nearest neighbours are at almost the same distance as in the solid This means that the vacancies created are not like static, locked-in vacancies as in the solid state, but mobile and fluidised. The molecules are in rapid motion jumping into the vacancies and smearing out the empty space so that light scattering experiments fail to reveal any heterogenity This loosening leads to the disappearance of any long range order. These vacancies or what are commonly called 'Holes', have been assumed to be of molecular size because such size would cause the least disturbance to those molecules, which at any instant, are not directly engaged in the motion of a vacancy

This model has been used to explain various existing laws like Law of rectilinear diameters which states that the mean density of a liquid and its vapour is almost independent of temperature, decreasing only slightly as the temperature increases, from the melting to the critical point. The explanation is very simple. If the vacancies can move as freely as vapour molecules, the energy needed to form a vacancy will equal the heat of vaporization. Consequently we may expect the some concentration of vacancies in the liquid state as a of molecules in the vapour and hence the sum of the two densities should be constant. This is what, in fact, is observed.

Hilderbrands Evidence for Maximum Randomness

But the above hypothesis has been challenged by Hildebrand who believes that a pure liquid, if composed of non-polar, symmetrical, compact molecules has a structure of maximum randomness, these are not quasi-crystalline structures; no holes of definite size or shape; no distinguishable "gas-like" or "solid-like" molecules. He puts

forward, a wealth of evidence to support his contention.

1. X-ray photographs of liquid and solid gallium at the same temperature reveal lines for the solid, but no line for het liquid.

2. White phosphorus can be cooled to —70°C (m.p 44°C) without showing any sign of lattice structure.

3. Some silicons have sizes of holes 5 times longer than volume of an iodine molecule When iodine is added to these liquids, both expand, Iodine does not find any holes there.

4. The thermodynamic function that gives information about structure, is entropy. He has found in large number of experiments that entropy of mixing is not sensibly affected by disparity in molecular volumes

5 According to "Hole Theory", diffusion takes place by jumps in lengths of molecular diameter, from a lattice site into a hole, with an energy of activation, required for surmounting a barrier. But temperature coefficient of diffusion at constant volume shows that it depends simply upon the kinetic energy of molecules and that all molecules take part in the random walk and in steps much smaller than molecular diameter.

Rice's Formal Approach is through direct calculation of distribution functioning (r) without assuming any special model. Here he makes use of the time smoothing method for irreversible problems in strongly interacting systems as advocated by Kirkwood.

|Dissipative processes arise from transport of mass, momentum and energy. In each case, there exists a relationship between a flux and the force which is responsible for the flux.

|Dissipation also accompanies relaxation process. In some cases, the relaxation time for reorientation is approximately proportional to the Viscosity of the liquid. Now in a dilute gas. the transport of mass, momentum and energy occur by the actual movements of individual molecules from one place to another. In a crystalline solid, the transfer of energy is affected by lattice vibrations, without requiring on the average, the displacement of any molecule. Also in a gas, a molecule may move freely until it collides with another, but in a solid, displacement from one to another lattice site requires imperfections—vacancies or dislocations before molecular motion is possible.

In the liquid, the motions are very complex with characteristics between those in a gas and a crystalline solid.

To reconcile the time reversibility of mechanics, with the time irreversibility of dissipative phenomenon Kirkwood's time-smoothing method is probably the only method available

The Liquid State II

In part I, I have stated the modern views about the liquid state. In Part II, I would like to discuss the salient features of some typical liquid systems. *Water*—Though water is regarded as a standard for many physical properties e.g. density, calories temperature, viscosity etc., it is one of the most abnormal liquids. The reason for its abnormality lies in its structure. It contracts on melting. It belongs to a class of liquids to which a random packing of simple shapes cannot apply. It is paradoxical that oil and water which have same type of structure do not mix. Its boiling point, freezing point etc., are markedly higher than those of compounds of similar elements in group VI of the periodic table.

About two years ago, a new form of

water which did not boil up to 500° C and freeze upto—20°C, whose density and viscosity were appreciably different from that of ordinary water, was announced by a Russian Professor Deryagin. Prof Lippincott of U S.A. called it "Poly water" and proposed a new structure for it. On further critical examination by Drs. Rousseau of the Bell Telephone laboratories and Porto of the University of California, the so-called poly water has been found to contain boron, silicon and nitrogen as impurities. The presence of these impurities is responsible for the unusual properties exhibitied by the so-called Polywater.

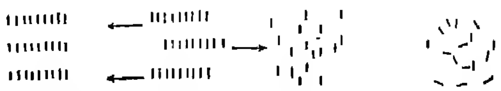
Liquid Crystals

You will be wondering as to what do these two words mean How can a substance exist in two quite different states of matter at the same time. What the words simply mean are that the substance is liquid in its fluid behaviour but crystalline in its optical characteristics. Its structure, though more or less mobile, contains numerous regions where the molecules are aligned in a fairly regular manner.

Materials which are termed as liquid crystals, do not pass on heating from the solid to normal isotropic (having same properties) liquid. On the other hand, the solid melts to form first a milky fluid, which in some cases is very greasy, while in others, quite mobile. On continued heating, a normal liquid is obtained. The transition from solid to liquid can be represented as

Solid $\rightleftharpoons$ (Three dimensional) Order
Mesophase $\rightleftharpoons$ (Two I dimensional) Order
Mesophase $\rightleftharpoons$ (One II dimensional) Order
Liquid (Zero dimensional) Order

The transition temperatures are definite and reversible for a pure substance, though they are very sensitive to presence of impurities. Graphically these phases may be represented as:



Crystalline Solid **Mesophase I** **Mesophase II** **Isotropic Liquid**

It has been estimated that about one in every 200 organic compounds shows liquid crystalline properties Remembering that the number of organic compounds runs into millions, study of liquid crystals is worthwhile, both from the structural point of view and the applied side of them.

Liquid crystals usually have molecules which are long, thin and often flat, possessing both lateral and terminal attraction for each other, e.g. alkoxy benzoic acid, cholesteryl esters of fatty acids etc. These compounds need to be sufficiently polarizable for dipole and induced dipole attraction to be significant. This is often achieved by the presence of benzene rings and multiple bonds.

Many solutions of soaps and detergents show liquid crystalline behaviour over particular concentration ranges. Various phases are formed through the formation of different types of micells. In some cases, as many as five phases have been reported. Potassium palmitate (ordinary handsoap) shows phase I behaviour in the range 30-50 per cent and normal isotropic liquid behaviour at still lower concentrations.

Liquid crystals are compounds of the future. The first international conference on liquid crystals was held in 1965 at....and the second is yet to be held. Some of their applications can be outlined as below:

(1) They can function as orientating

solvents for improving resolution in e.s.r and n.m.r. investigations Since they themselves possess some order, they can presumably cause the ordering of a solute dissolved in it.

(2) Cholestic materials are proving useful as temperature indicators from—25° to 250° C either singly or as mixtures because they show a particular colour at a given temperature They have been manufactured as flexible heat-sensitive tapes and films and have also been applied to skin to delineate veins and tumours through skin-temperature differences.

(3) Some phases are influenced by an electric field at a charged surface. This property is used in preparing polarising films on glass or plastics. A suspension of the appropriate phase in water (or any other suitable solvent) is spread over the surface and water evaporated carefully leaving behind a liquid crystal aligned on the surface which is able to act as a polariser.

(4) Liquid crystals have been found very valuable as stationary phases in gas-liquid chromatography, because they can act selectively as solvents in separations. They will accept molecules possessing structures as their own in their liquid crystal lattice. Thus those molecules will have increasing solubility and hence longer retention time

(5) They also appear to have important biological roles since many substances present in brain or nerves show liquid crystalline behaviour at physiological temperatures

There are many other uses to which these substances can be put. The study of liquid crystals is an eye opener for organic chemists who may try to discard an otherwise pure compound as an inseparable mixture, simply because they are not famillıar with the mesomorphite properties of the compound To verify whether a compound exhibits mesomorphic behaviour or not, a small sample of the compound is heated on a microscopic slide till the crystals pass into the isotropic liquid. A cover slip is now pressed on the slide to give a thin section of the material, care being taken that no air bubbles are entrapped anywhere. When they are allowed to cool slowly, the following well defined regions will be observed. If a high melting impurity were the cause of the appearance of turbidity on melting, such definite regions will not be observed, the change from the solid to molten will be ill-defined.

Liquid Metals

Yet another interesting class of liquids are liquid metals for example, Mercury, Calcium etc While their liquid properties can be explained on the basis of the classical kinetic theory of matter, their metallic properties need the insights of quantum theory.

There are some elements which display metallic properties only in the liquid state. For example Silicon and Germanian are semiconductors in their crystalline form, but behave as metals in their molten form.

It would be interesting to compare some of the properties of liquid metals and other normal liquids. One such peoperty is Number Density. 1 c c of water at 4°C contains 3.4×10^{22} molecules, 1 c c mercury at—38°C also contains 4.1×10^{22} ions inspite of the fact that bulk density of mercury is 13.6 times that of water. This shows that atoms in any liquid are on the average only 2-3 A° part (of number density in gas 10^{19} per c.c.)

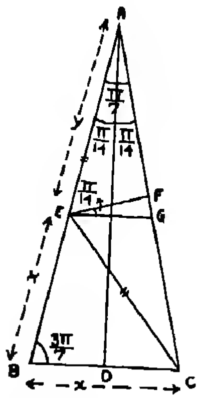
The basic properties normally connected with liquids (such as viscosity, surface tension and diffusion) are comparable in liquid metals and normal liquids The essential difference between the two types of liquids lies in thermal and electrical conductivity, optical reflectivity and compressibility.

Liquid metals are much more incompressible than other liquids, consequently the velocity of sound in liquid metals is usually higher than in other liquids Similarly, the thermal conductivity of liquid metals will be appreciably higher than the normal liquid. Sodium and Potassium because of their low melting points are used for transport of heat in nuclear reactors.

A Method of Finding Trigonometrical ratio of $\frac{\pi}{14}$

DR. RAMESHWAR RAO

A very interesting method, involving elegant geometrical manipulations and solving of a cubic which falls under Cardan's irreducible case, by trial and error, for finding the value of Sin $\frac{\pi}{14}$, is discussed



INTRODUCTION· Methods of the trigonometrical ratios for the acute angles $\frac{\pi}{2}$, $\frac{\pi}{3}$, $\frac{\pi}{4}$, $\frac{\pi}{6}$, $\frac{\pi}{10}$ etc., have been discussed in many books on trigonometry. But somehow the angle $\frac{\pi}{14}$ seems to have escaped similar consideration. In this short note, the trigonometrical ratios of $\frac{\pi}{14}$ are discussed in an elegant manner.

It is sufficient if we can find Sin $\frac{\pi}{14}$, for when the Sine of an angle is known, every other trigonometrical ratio of the angle can be found automatically

2. A METHOD OF FINDING SIN $\frac{\pi}{14}$.

Let ABC be the triangle in which $\angle A = \frac{\pi}{7}$ and $\angle B = \angle C$.

$\therefore \angle B = \angle C = \frac{3\pi}{7}$

Draw AD $\perp$r to BC. Then $\angle BAD = \angle CAD = \frac{\pi}{14}$

Let CE meeting AB at E be drawn through C making an angle $\frac{\pi}{7}$ with CA.

Then $\angle BCE = \frac{2\pi}{7} = \angle BEC$.

$\therefore$ BE = BC = x (say)

By construction, AE = CE = y(say)

Then Sin $\frac{\pi}{14}$ = Sin $\angle BAD$

$$= \frac{BD}{BA} \quad \frac{\frac{1}{2}BC}{BE+AE} = \frac{\frac{x}{2}}{x+y} = \frac{x}{2(x+y)} \Bigg\} \ldots (1)$$

Draw EG, meeting AC at G, parallel to BC and draw EF⊥r to AC.

Then $AF = FC = \frac{1}{2}\ AC = \frac{1}{2}\ AB = \frac{x+y}{2}$

$$\therefore FG = AG - AF = AE - AF = y - \left(\frac{x+y}{2}\right) = \frac{y-x}{2} \Bigg\} \quad ..(2)$$

$\frac{AE}{AB} = \frac{GE}{BC}$ ($\because$ EG ∥ to BC)

i.e., $\frac{y}{x+y} = \frac{EG}{x}$ given $EG = \frac{xy}{x+y}$ ..(3)

$\angle AEF = \frac{1}{2}\ \angle AEC = \frac{1}{2}\{\ \pi - (\angle EAC + \angle ECA)\ \}$

$= \frac{1}{2}\ (\pi - \frac{2\pi}{7} =) \frac{5\pi}{14}$

Since EG ∥ to BC, $\angle AEG = \angle ABC = \frac{3\pi}{7}$

$\therefore \quad \angle FEG = \angle AEG - \angle AEF$

$= \frac{3\pi}{7} - \frac{5\pi}{14} = \frac{\pi}{14} = \angle DAB$

$\therefore$ The two right angled $\triangle$s FEG and DAB are similar.

$\therefore \frac{FG}{GE} = \frac{BD}{AB} = \frac{x}{2(x+y)}$. (4)

From (2), (3) and (4),

$$x^3 + 2x^2y - xy^2 - y^3 = 0$$

Hence, putting $y = ax$ ....(5)

this equation reduces to

$$a^3 + a^2 - 2a - 1 = 0 \quad . (6)$$

Put $a = b + k$

Then (6) becomes

$$b^3 + (3k+1)b^2 + (3k^2 + 2k - 2)b + k^3 + k^2 - 2k - 1 = 0 \quad .(7)$$

Hence, putting $k = -\frac{1}{3}$, (7) reduces to

$$27b^3 - 63b - 7 = 0 \quad . (8)$$

Let $3b = u$, then (8) becomes

$$u^3 - 21u - 7 = 0$$

giving $u = \left(\frac{7}{2}\right)^{\frac{1}{3}} \{\ (1 + i3\sqrt{3})^{\frac{1}{3}} + (1 - i + 3\sqrt{3})^{\frac{1}{3}}\ \}$

thus falling under Cardan's irreducible case. Hence, *tackling* (6) by trial and error method, the relevant real value of

$$a = \frac{5}{4} \text{ (approximately)} \quad ..(9)$$

$\therefore$ From (5) and (9).

$$y = \frac{5}{4}X \quad ..(10)$$

$\therefore$ From (1) and (10)

$$\text{Sin } \frac{\pi}{14} = \frac{2}{9} = 0.2 \text{ (Approx.)}$$

3. A REMARK.

L.H.S. of (6) $= a^3 + a^2 - 2a - 1 = X$ (say)

When $a = \frac{5}{4}$, $X = -\frac{1}{64}$.

Now, putting $a = \frac{6}{5}$, $X = \frac{-29}{125}$;

and $\frac{1}{64} < \frac{29}{125}$.

Hence, putting

$a = \frac{1}{2}\left(\frac{5}{4} + \frac{6}{5}\right) = \frac{49}{50}$, we get

$X = \frac{-12783}{64000}$, and $\frac{1}{64} < \frac{12783}{64000} < \frac{29}{125}$

Hence, Putting

$a = \frac{1}{2}\left(\frac{5}{4} + \frac{49}{40}\right) = \frac{99}{80}$, we get

$X = \frac{-34821}{512000}$; and $\frac{1}{64} < \frac{38421}{512000} < \frac{12783}{64000}$

Hence putting

$a = \frac{1}{2}\left(\frac{5}{4} + \frac{99}{80}\right) = \frac{199}{160}$, we get

$X = \frac{-68111}{4096000}$; and $\frac{1}{64} < \frac{68111}{4096000}$
$< \frac{34821}{512000}$

Hence, putting

$a = \frac{1}{2}\left(\frac{5}{4} + \frac{199}{160}\right) = \frac{399}{320}$, we get

$X = \frac{-113681}{32768000}$; and $\frac{113681}{32768000} < \frac{1}{64}$

Hence $a = \frac{399}{320}$ is the more approximate root of (6) than $\frac{5}{4}$.

Hence, substituting $y = \frac{399}{320}X$ in (1), we get $\sin\frac{\pi}{14} = \frac{160}{719} = 0.222531$ (approx); thus we can find the trigonometrical ratios of $\frac{\pi}{14}$ to any required degree of accuracy.

Also, the relevant real root of (6) can be found to any required degree of accuracy by Horner's Method of approximation; for obtaining the trignometrical ratios of $\frac{\pi}{14}$ to any required degree of accuracy.

Classroom experiments

Parallelogram Apparatus

RAJENDAR KUMAR BHASIN

The following are the defects in the existing parallelogram apparatus:-

(i) We fail to find the resultant of two forces if the angle between them is given e.g. we are asked to find the resultant of 50 gm. wt. and 100 gm. wt. when it is given that they are acting at an angle of 60°.

(ii) The apparatus gives only the resultant force in magnitude but it fails to give its direction until we sketch a parallelogram on the paper.

(iii) We fail to take observations when the angle between the given forces becomes very small or large. At this instant the meeting point of 0 of threads goes out of the paper sheet, therefore we are bound to avoid these angles.

(iv) The directions of the given forces and resultant are marked on the paper with the help of a mirror leaving a possibility of an error.

All the above defects of the existing parallelogram apparatus have been removed completely in the present apparatus.

Some special features of the present apparatus are:

(i) that the apparatus is able to find the resultant of two forces even if the angle between them is given.

(ii) that the apparatus also gives the direction of the resultant force accurately without sketching any parallelogram on a piece of paper.

(iii) that the apparatus gives accurate readings howsoever the angle between the given forces may be small or large.

(iv) that the direction of the given forces and the resultant are indicated correctly by the pointer on the circular scale, hence the chance of error in direction is completely removed.

Construction of the apparatus

The apparatus consists of a vertical metallic rod V screwed tightly on a heavy base B. Three metallic arms p.q. and r are attached to the lower portion of rod V by means of bush and seat arrangements so as to make them rotate coaxially round the vertical rod V. A circular scale is attached horizontally at the top end of the rod V. The position of the centre of the scale is indicated by said pointed end of the rod. A frictionless pulley is attached to the end of each metallic arm and a pan is suspended on each metallic arm by means of an inextensible thread passing over the pulley. The ends of the three threads are stitched at a common point 0. One metallic pointer to each metallic rod vertical rod point on the circular scale smoothly. The three

pulleys L, M and N and the pointed end C of the rod V lie in the same horizontal plane.

Working of the apparatus

Let W_1 and W_2 gm. weights be placed on the pans of pulleys L and M respectively. Let the position of the pointers of arms p and q be Q_1 and Q_2 respectively (Q_1 and Q_2 can be put as we like) Now we place weights on the pan of pulley N and the position of arm (r) is adjusted by rotating it round the vertical rod till it comes in the same vertical line In this position the apparatus is said to be balanced.

Suppose, to obtain the balanced position W_3 gram weights are to be placed on the pan of pulley (n) and the position of the pointer of arm (r) is Q_3 Let the weights W_1, W_2, W_3 represent the forces P, Q and R respectively. Evidently the balanced position of the pointers will indicate the direction of the forces P, Q and R.

Therefore

(i) the angle between the forces P and Q $= (Q_1—Q_2)$

(ii) resultant of the forces P and Q = R

(iii) Actual position of the resultant R = $(Q_3—180)$

(iv) the angle which the resultant makes with the force P $= [Q_1—(Q_3—180)]$

Hence the apparatus can be used.

(i) for finding out the resultant (both in magnitude and direction) of two forces acting at a given angle

(ii) For the verification of law of parallelogram of forces

(iii) For the verification of law of triangles.

(iv) For the determination of weight of a given solid.

(v) For the determination of R.D of a given solid.

Science Abroad

Lift-off with a Difference

B V JAYAWANT

Reader in System and Electrical Engineering
University of Sussex

A system of magnetic levitation developed at the University of Sussex, south-east, England opens up a number of important industrial applications The new system, discovered by Dr. B V Jayawant, Reader in Systems and Electrical Engineering at the University's Applied Sciences Laboratory, has already enabled the completely free and stable suspension of weights of 100 grams to 5 kilograms under a self-regulating electromagnet

In this article, Dr Jayawant, discusses how his friction-free system could be used to leviate much heavier bodies, including trains travelling at more than 300 miles (480 kilometers) per hour

LEVITATION of objects has fascinated philosophers and scientists through the ages. Speeds of industrial processes; speeds of trains; purification of metals, all come up against the same problem that of elimination of physical contact and, therefore, friction. Several methods have been considered and have found applications—for example, a cushion of air, repulsion between like poles of permanent magnets; eddy currents, including those in superconductors and even a force of attraction of an electromagnet with a control of its excitation and hence its strength.

Recent work on levitation in the Applied Sciences Laboratory of the University of Sussex, south-east England, has been concerned with yet another method, using alternating current circuits with a condenser in series. In this method the proximity of an iron object to the electromagnet throws the circuit off-tune. This effect is utilised to obtain an electromagnet, the strength of which is self regulating—if the suspended iron object gets too close to the electromagnet the current diminishes, providing a reduced force, and *vice-versa* if the object descends too far. However, there is a tendency for the suspended objects to go into oscillations, and without some means of control of these oscillations the objects fall down. The work done since May 1968 has been on the control of these oscillations Completely stable and free suspension of objects weighing from about a 100 grams to 5 kilograms has now been achieved for as little as 25 to 30 watts per kilogram of suspended weight.

Many Industrial Applications

The progress made in the last twelve months which has enabled weights of the order of 5 Kilograms to be suspended leads one to believe that, with due regard to the engineering difficulties, it should be possible to suspend considerably bigger weights. There are, however, a large number of applications in the range of weights which have already been suspended, including frictionless bearings, conveyor belts for moving objects at comparatively slow speeds and precision balances, to name a few.

Frictionless bearings would be attractive for a number of instruments such as wattmeters or magnetometers, by making them much more sensitive. A novel applicatino

By Courtesy, British Information Service.

has been suggested for a low wind velocity measuring anemometer. It consists of a ferrite rod which is suspended under the electromagnet. The rod has vanes like a windcock or a windmill and because there is absolutely no friction, the slightest draught of wind will cease it to spin round. This type of instrument, it is suggested, would be very useful in coal mines to detect seeping gases of the order of 2 miles per hour (3-2 Kilometres per hour) or even less which might cause explosions.

A considerable amount of power is wasted in industry in overcoming friction in bearings of one kind or another. In applications such as gyro-rotors, complete elimination of friction would enable considerable reduction in driving power. In the textile industry, especially in synthetic fibres, production could be increased by three to four times. At present the yarn can be produced a lot faster than it can be wound. The limiting speeds for spinning spindles and bobbins, due to frictional losses, are about 12,000 revolutions per minute. But with frictionless suspension such as the one achieved by tuned circuits, this speed could be raised to 50,000 revolutions per minute and would require less power than that required to spin them at the current speeds. Work is also going on at Sussex to develop high speed motors which will spin the spindles at these high speeds, so forming an integral unit

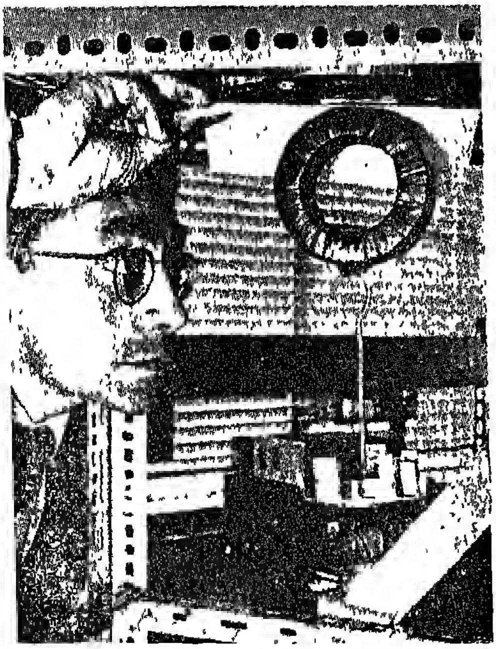


Fig 1.

The author demonstrating his method of magnetic levitation by inserting a piece of paper in the space between a special, self-regulating electromagnet and a suspended tray of weights His discovery has already enabled the completely free and stable suspension of weights of 100 *grams to* 5 *kilograms under the electromagnet for an outlay of as little as* 25-30 *watts per kilogram of suspended weights*

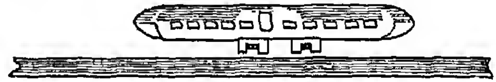


Fig. 2.

This diagram shows how the system of magnetic levitation can be used to provide frictionless passenger transport at speeds of more than 300 *miles* (480 *kilometres) per hour. The suspended carriage with two tuned circuit magnets on its "roof", acts as an electromagnet running under a laminated "monorail" supplying the power*

Moving—In Mid Air

Perhaps the ultimate in fascination is a leviated moving body. The amount of development required to extend the tuned circuit suspension to movable objects will be considerable and costly but it will be challenging and exciting

A use which at present looks too costly but which may prove feasible in time is the movement of iron ore.

Iron ore is brought by ships in the form of 3 ×3 foot (91 × 91 centimetres) bricks and is taken by trucks directly from ships to furnaces, resulting in considerable breakages,

Since the ore is magnetic it could be suspended under the tuned circuit magnet. If these bricks could be moved along as well, as on a conveyor belt, it would be an attractive proposition to replace the trucks by a "conveyor belt" of electromagnet suspension.

Work is going on to extend the idea of tuned circuit suspension to moving inert suspended objects along a line—not to be confused with the idea of moving suspended carriages which is described later. An application which looks quite promising is that of coating metal buckles, clips and so on in plastic At the moment this is done by dipping the item in a fluidised bed and transporting it, suspended on a hook, through an oven. But at the and of the process, the hook leaves a mark which has to be rubbed off, especially if the buckles are used on synthetic fibre garments.

Counterpart to Tracked Hovercraft

Probably the most exciting application of the magnetic levitation principle which could come about is in high speed transport where it could be a silent rival to tracked hovercraft There will have to be a considerable amount of development to do this and we also must first find out if there is a need for trains running at 300 miles per hour (480 Kilometres per hour).

The proposed arrangement for high speed transport is an inverted form of those described so far, so that the electromagnet is in this case the suspended body. There have to be two magnets coupled together under a laminated "monorail". Ultimately even the power supply might be located in the suspended "carriage", making it completely self-contained. A similar arrangement could be used to carry heavy objects from one part of the factory floor to another at comparatively slow speeds

Many other applications have been considered, but in one particular field things have come round full circle—it has been suggested that magnetic levitation might be of interest to members of the Magic Circle

Detecting Astral Secrets with Infra-Red Telescopes

JOHN GRIBBIN
Institute of Theoretical Astronomy, Cambridge

A 60-inch (150 centimetre) infra-red telescope designed and built by the Imperial College of Science, London, will be the biggest of its kind in the world A second such telescope twice as big is also planned.

Infra-red telescopes are giving astronomers entirely fresh information about the universe since more light is gathered at the red end of the spectrum and some stars radiate mainly in that range The new facts in turn could well influence the present scientific controversy on cosmic origins.

WHENEVER astronomers are able to break new ground by constructing detectors which operate at previously unused wavelengths there is a considerable step forward in our knowledge of the universe. This was particularly noticeable when radio astronomy began and, more recently, X-ray astronomy has also begun to be significant.

The next obvious development is the construction of large telescopes designed to

By Courtesy, British Information Service.

investigate the infra-red radiation falling upon the earth from other celestial objects, and Britains' Science Research Council (SRC) is playing a large part in setting up suitable observing stations.

So far, the great difficulty about detecting infra-red waves from space has been that these waves are particularly likely to be absorbed by water vapour in the atmosphere; at first, high altitude observatories seemed the best sites for setting up infra-red telescopes, but work carried out in the European Alps by Professor James Ring, of Imperial College, London, has shown that this mountain site at least is far from ideal

Other Sites Favoured

Instead, the island of Tenerife or Southern Spain are now more widely favoured, and the SRC has provided a grant of just over £27,000 for Imperial College, in collaboration with other infra-red astronomers in Britain, to design and construct a 60-inch (150 centimeter) infra-red telescope and to test sites for suitability for infra-red astronomy.

Then the 60-inch telescope can be set up at the site where best results are obtained, at which time a new 120-inch (300 centimetre) telescope will probably be commissioned to work with the 60-inch. The limitations imposed by this need for a simple telescope have prevented the Imperial College team from incorporating many new ideas into its design, though the 120-inch telescope will probably be more sophisticated.

For the 60-inch, with a target date of late 1970 for the commencement of a full observational programme, they have stuck to the well-tried "equatorial" mounting, where one of the two axes on which the telescope rotates points to the celestial pole and the other is perpendicaular to this axis

With this set up, the telescope has only to be pointed at any interesting star at the start of an observation. Then, until it is reset a simple motor will turn the whole apparatus about the polar axis at exactly the rate necessary to compensate for the earth's rotation.

Easier Engineering Job.

For larger telescopes, it is an easier engineering job to have the two rotation axes coincide with the local horizontal and vertical axes since this imposes less strain on the mechanism, but the telescope must then be steered in a more complex fashion using a fairly expensive (and difficult to move) computer This so-called altazimuth mounting is used for all of the large steerable radio telescopes, including the famous giant aerial at Jodrell Bank

Meanwhile the SRC are contributing £ 40,000 over the next four years to an infra-red observatory developed jointly by the Universities of Minnesota and California, in the United States of America, which already have a 30-inch (75-centimetre) telescope. Though this contribution will eanble United Kingdom astronomers to get immediate experience of infra-red astronomy, and information about its results, the purely British venture seems to be a much better bargain both financially and scientifically.

Astronomers both in Britain and abroad are delighted by the strong backing being given to infra-red astronomy by the SRC. Theories ranging from the composition of dust grains in our galaxy to the energy generated in quasars, the most distant and energetic objects yet known, are all dependent on information available only at these wavelengths.

A leading expert on interstellar dust, Dr. N.C. Wickramasinghe, of Cambridge Institute of Theoretical Astronomy, has for a long time believed that these dust grains are made up of graphite and solid hydrogen

while others have argued in favour of compositions containing the more complex silicates.

This conflict can only be resolved by studying the infra-red radiation from these grains, when the discovery of spectra characteristic of one or the other group molecules will settle the issue.

Surprise for Astrophysicists.

The most exciting developments from this new branch of astronomy seem likely to shed light on problems involving stellar evolution and our knowledge about the whole universe obtained from studies of very remote objects. One of the surprises for astrophysicists in recent months has been the collapse of their ideas about the origin of the infra-red radiation coming from some individual stars

A theory had been carefully built up which accounted for these infra-red stars, detected by the relatively small infra-red telescopes existing now, in terms of collapsing proto-stars (that is, stars in the process of formation from collapsing clouds of gas). This idea was widely accepted since such proto-stars must be cooler than normal stars, and infra-red radiation corresponds to cooler temperatures than normal visible light, just as a red hot piece of metal is likely to be cooler than one which is white hot.

But this simple picture may now have to be abandoned, since some theoreticians argue that if old stars have the free hydroxyl radical (OH) present in their atmospheres then naturally occurring infra-red radiation from these stars can interact with the OH to form a natural maser amplifier (like a laser but producing intense radiation at microwave frequencies rather than a beam of intense light.)

This idea explains how some of the stellar microwave radiation which has already been detected could have originated, but at the expense of the simple picture of infra-red stars first suggested. Of course, it may well turn out that both young and old stars emit infra-red radiation. What is certain is that the situation is much more complicated than was realised at first, and there is an urgent need for large telescopes like those now being constructed by astronomers in Britain

Problem of Quasars

Everyone connected with astronomy must, at one time or another, have turned his attention to the problem of quasars. Since their discovery less than 10 years ago, opinions have varied as to whether they are near-by objects, shot out from our own galaxy in some fantastic explosion millions of years ago, or whether they are at huge distances from us, the most remote objects yet discovered, and hence pouring out huge quantities of energy in order to be visible at such long ranges

At present, the best opinion seems to be that they are indeed very distant and this means that they are also the most valuable objects visible for the cosmologists who study the whole universe rather than "local" objects like stars.

Still, before the cosmologists can be completely happy about the deductions they draw from the distribution of quasars, one of which has put the steady state theory out of favour and caused a return to the older idea of a "big bang" universe, the astrophysicists must explain the origin of the energy liberated in quasars.

This question is the very corner-stone of ideas affecting the whole of physics, which are advocated by Professor Fred Hoyle. Hoyle questions one of the most fundamental of all our theories, suggesting that gravity itself no longer obeys the simple inverse square law of attraction inside quasars and

that the effect of this on the matter of which they are made up can explain why they are so bright and energetic.

Early measurements by small infra-red telescopes suggest that the quasars are even brighter at infra-red wavelengths than in the visible light If so, this must make it even more difficult to account for this energy by simple nuclear physics, and it must therefore strengthen Hoyle's position. Better measurement with larger infra-red telescopes have a vital bearing on this problem.

Finally, the mention of quasars brings me to what may be the most important result of improved infra-red -astronomy. Until radio astronomy developed, the quasars were unimagined—no one conceived any idea that such object existed. Who knows what as yet unimaginable discoveries might be made when infra-red astronomy has grown to a similar extent

Sex Scents to Control Insect Pests

by EDWARD ASHPOLE

Many insects find their mates through sex scents which can be carried by the wind to reach potential partners. Female moths, for instance, are known to have attracted males from as far away as 2 miles Such potency offers a weapon against insect pests and today chemists are working to discover the chemical structures of insect sex scents and to synthesize them for use in large-scale pest control

SYNTHESIZED sex scents can be combined with poisons to trap and kill insects But a more interesting approach to insect control is to use sex attractants to lure males which are then sterilized. They are afterwards released and their subsequent matings are infertile

So far, chemists have discovered the structure of three insect sex attractants—those of the silkworm moth, the gypsy moth and the honey-bee. All these have had their chemical structures confirmed by synthesis.

In London, at the Tropical Products Institute, work has been in progress on insect sex secents for over two years Dr. Brenda Nesbitt and her research group are working there at present on the attractant of the red bellworm moth, a brown coloured necturnal moth of medium size. The moth gets its name from its Larvae These eat the flower buds and the green bolls of cotton plants. They are red in appearance when nearing maturity.

"This moth is one of the major pests of cotton," Said Dr. Nesbitt, in explaining the work in her laboratory. "It occurs only in Africa, and the particular species on which we are working occurs only in south-eastern Africa. But a closely related species also lives north of the equator in Nigeria and the Sudan.

"At present the moth is controlled by intensive pesticide spraying; it takes about twelve sprayings a year to control the pest Spraying, of course, is liable to lead to resistance of the insect to the pesticide, but without it cotton crops are badly affected by the moth's grubs "

About 50,000 pupae of the red bollworm moth were sent to the Tropical Products Institute during 1965. From the moths that emerged from these, Dr. Nesbitt and her group were able to obtain active extracts of the moth's sex attractant.

"We've clipped off the abdominal tips of the female moths and have made solvent extracts of these which we 've been able to

show are attractive to male moths, both in the field and in the laboratory," explained Dr Nesbitt.

The other method of obtaining the attractant has been carried out by scientists in Rhodesia and Malawi, one of the countries badly affected by the moth They have passed a stream of air over virgin female moths, the air stream has been cooled and the attractant condensed out Dr. Nesbitt pointed out that it is difficult to imagine the process being scaled up Chemists in the United States have used the same method to obtain the sex attractant of the cockroach, but cockroaches are far tougher insects than moths and they live much longer.

"The moths we're working with," said Dr Nesbitt, "are very short lived They don't feed as adults and live for only a couple of weeks. So we favour the tip extraction method for dealing with a large-scale collection of moths.

"We've done preliminary work on the purification of tip extracts, but much of our time so far has been devoted not to chemical but to entomological work. We have had to find a means of testing the attractant in the laboratory because when testing in the field, catches are affected by weather, by how many wild female moths there are in the area at the time and by other factors that can't be controlled."

Dr Nesbitt explained that the attractant is far from infallible. "In the early stages of the project," she said, "one experimental officer sat up all night with a selection of moths that he had taken home with him, watching them to see if they were interested in one another. But the conditions couldn't have been right because the male moths set one side of the cage and the female moths set at the other side and there was just a very weary assistant the next morning and no sign of response at all from the moths "

The group's present methods, however, show how well the attractant works. "We now have a trapping method which we run overnight We simply have two traps: one blank and one containing the attractant. We put the extract to be tested, absorbed on cotton wool rolls, in one of the traps, release male moths around the two traps and in the morning record the number we have caught. We had to experiment with lighting conditions, temperature and humidity, but we can get reasonably good catches now.

"We put about thirty male moths in the traps at five O'clock in the evening; we check them at eight 'o'clock the following morning. Using virgin females as bait, catches of up to 90 per cent of the liberated males have been recorded, but with extracts catches are usually much lower. It may be that it's better to start this experiment about midnight, because in the field the moths are most active between one and four o'clock in the morning. Alternatively, it may be that the attractant evaporates rapidly so that it's not at its maximum concentration at the time when the males are most receptive. We' re going to investigate this."

After a laboratory examination of the effects of the attractant, the groups next step will be to discover the attractants' chemical structure. "We're nowhere near this yet though," Dr. Nesbitt explained. "If the work already done in this field with other insects is any guide, we've not had enough moths yet to be able to get a reasonable amount of material. For the gypsy moth attractant the Americans needed half a million females. Even this number gave them only ten milligrams of material. With the pink bollworm moth which U.S. Department of Agriculture scientists have been working on at Beltsville, Maryland, nearly a million moths have been processed just to

four milligrams of attractant. This is a smaller moth than the red bollworm moth, but we'll almost certainly need a much larger collection of moths to be able to work out the structure of the attractant."

How long might it take to discover the structure of the moth's sex attractant?

Dr. Nesbitt explained, "If we're lucky we may know in two to three years time. Once this is done the time required for the actual synthesis of the attractant depends upon whether it' is a similar compound to the insect sex scents already known. The two main ones so far discovered—the silkworm moth studied by German workers and the gypsy moth investigated by the Americans—do not have very complex chemical structures Both these sex attractants have been synthesized

"American workers have isolated the attractant of the cockroach, but its exact structure is still in doubt Also, there's the pink bollworm moth—a serious pest to cotton in the United States. The structure of this moth's sex attractant is known, but it will not be published until workers there have confirmed its structure by synthesizing it."

On the nature of scent and smell little is known. Dr. Nesbitt said, "The entomologists are very interested in the subject and have many theories about how insects are able to track attractive scents to their source At one time it was thought that the insects simply flew up a concentration gradient to the scent, but this no longer seems likely One drawback to this theory is that the scent is not spread out by the wind into a cloud which decreases in density from the source, instead, the scent exists in complex patterns of filaments A theory put forward by a Canadian entomologist, R.H. Wright, takes this into account. It is suggested that the insect receives the smell as a series of pulses at irregular intervals; so long as the interval between these pulses is decreasing, the insect continues to fly in one direction; but if the interval lengthens, the insect makes a series of violent zig-zags until the frequency of the pluses is again increasing. However, even this theory was found to fall down when certain fruit flies were tested—they were found to fly upwind towards a scent by using landmarks to guide them."

But whatever the mechanism of scent and smell turns out to be, entomolgoists believe that insect sex attractants will be used more and more in pest control—that is, as soon as chemists can make them available. Their use avoids the disadvantages of conventional insecticides, especially the way in which a species of insect can become immune to a particular product For it is unlikely that the males of any species will ever become immune to sex.

Reprinted from *Spectrum* 26 July, 1966

New Technique Advances Cell Research

EDWARD ASHPOLE

DR. Yeoman's group is studying the general physiology, biochemistry and mechanics of cell growth and division in plants,. In particular, they are interested in the specific functions of the various plant organelles and how these functions relate to changes in structure.

For their research they use tubers of the

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*Reprinted with the permission from *Spectrum* 68; 1970

Jerusalem Artichoke. From a tuber they can take a number of identical samples, each sample containing many thousands of cells of the same type. Such tuber cells would not normally grow any more; they are simply storehouses of food for the arti-

Fig. 1.
Jerusalem artichoke plants growing in the greenhouse

choke to use when it starts growing again. A hormone—auxin—is therefore needed to stimulate the tuber cells into growth and the synthetic auxin 2, 4D, is added to the synchronous cultures—without such an auxin the machinery of the tuber cells would not move into action.

Samples are cut from tubers and placed in a nutrient solution in a flask (see photograph). This is done with a number of tubers and flasks. The flasks are then set up on the mass cell culture apparatus. A small metal bar covered with plastic lies in each flask and there is a magnet beneath each flask. When the apparatus [illegible] on, the magnets revolve and turn the [illegible] bars within the flasks. In this [illegible] culture receives the same agitation.

Not all the tuber cells grow [illegible] that do grow do so at the same [illegible] cells removed from the tuber [illegible] up to the first division and [illegible] the next two generations. After [illegible] tions, however, synchronous growth [illegible] to break down and the culture [illegible] further use for the groups' investigations. It takes two days for the cells to pass [illegible] three generations and this [illegible] time for which the synchronous [illegible] apparatus is kept going. [illegible] during these generations the [illegible] of a very large number of cells [illegible] ped for biochemical analysis [illegible] of cell structures.

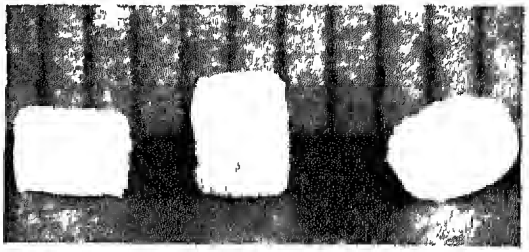


Fig. 2.
Explants removed from Jer[illegible] tubers. Each contain approximately [illegible] uninucleated cells

Several discoveries have been made [illegible] using this technique. Dr Yeoman [illegible] colleagues have found that light [illegible] affects the growth of these plant cells [illegible] unexpected way. Exposed to light [illegible] 30 percent of the excised tuber cells divide at the first division; but when the [illegible] are kept in total darkness, division [illegible] to 70 percent. No one has ever [illegible] this effect before; and why so many [illegible]

cells are able to grow and divide in darkness is not yet known.

Synchronous cultures have enabled the periodic synthesis of enzymes to be studied more effectively than before. It has also been discovered that during the cells cycle, RNA, which transmits genetic information from DNA in the processes of protein synthesis, is not synthesised continuously but in "packets".

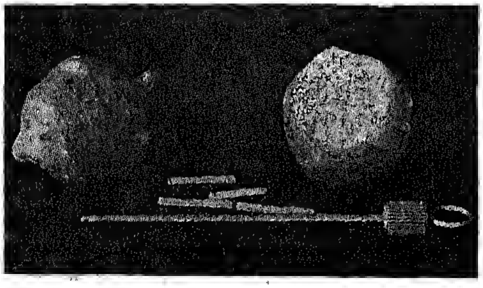
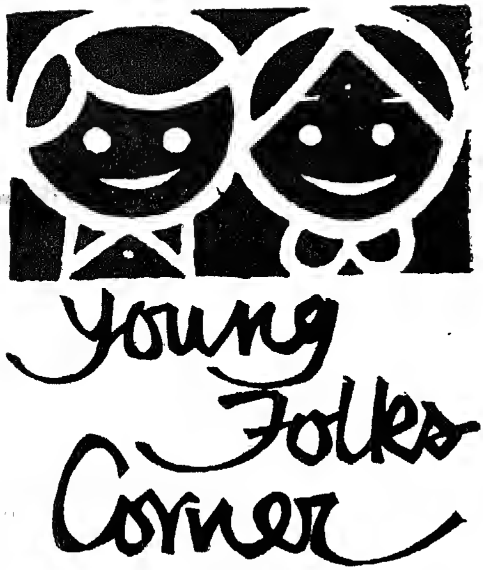


Fig. 3.
Tissues cylinders removed from subterranean tubers of Jerusalem artichoke.

"It is hoped that these studies will lead towards an understanding of why many of the metabolic events which precede mitosis are discontinuous", said Dr. Yeoman, "and help to explain the underlying mechanisms which control division".

Another observation concerns the mechanism by which the cell nucleus of a tuber cell gets into position for cell division. At rest, the nucleus lies flattened against the cell wall and is embedded in the cytoplasm. For cell division to take place a plate of cytoplasm has to be built up across the cell. Gradually the nucleus migrates to the centre of this structure and mitosis in division, then takes place. Dr. Yeoman and his colleagues have observed structures never before recorded which descend from the nucleus and seem to manoeuvre it into position.

It has been calculated that the cytoplasmic plate which traverses the cell contains 40 percent of the cell's protein and there are reasons for believing that this separating plate of cytoplasm may be all of the same protein. If so, this offers a marvellous tool for the future study of protein synthesis during the division of these plant cells.



Migration of Birds

S.K. Arora
Punjab Agricultural University, Hissar.

NO resident of India, who is even moderately observant, can fail to notice the great influx of birds that take place into this country between September and November, or to remark upon the abundance during winter in places where none were to be seen a couple of months before.

Thompson describes bird migration as "Changes of habitat periodically recurring and alternating in directions, which tend to secure optimum environmental conditions at all times". This back and forth movement is the crucial feature of migration of birds. The periodic movements of locust swarms, are really overflow movement and do not entail a return to the starting point. Thus they differ markedly from the seasonal return traffic of birds.

1. *Its extent and advantages*—Food getting under adverse conditions compel the birds to change their quarters or they may perish. Migration involves a swing from a breeding or nesting place-the birds home to a feeding or resting place-its winter quarters. Birds always rest in the colder portions of their migratory range, in Northern Hemisphere breeding grounds like arotic or temperate zone, and their winter quarters nearer the equator. In Southern Hemisphere it is reversed. Sometime it takes place from East to West. The extent varies from a few miles to a thousand miles and may be more. The longest known migratory journey is performed twice every year by a bird *Arotic Tern*, which from Arotic winter travels to South, right across the World to the Antarctic Summer, and back again, a distance of 11,000 miles each way.

Absence from high altitudes in winter enables (a) avoidance of cold and stormy weather, (b) avoidance of short day lights available for the search of food, (c) avoidance of those conditions which bring about a scarcity of food supply, such as freezing of water and snow in the surrounding ground.

The advantages of a return to high altitudes in summer are, (a) availability of suitable and uncongested nesting place, (b) existence of long hours of day light for search of food, when food is most required, and (c) the presence of an abundant food-supply following the luxiriant growth of spring vegetation.

Stimulations to migration are both external and internal. Primary external is the variation in day's length. The internal is provided by the state of Reproductive organs.

2. *Goal of migration*—In spring the adult males are first to arrive on their breeding grounds. Female adults follow them while immature birds bring the rear. In autumn the order is reversed, and there are

many stop-overs on the way. The young birds, in many cases lead the vanguard, the adults following later. It is an expression of an informal racial custom inherited through countless generations.

3. Altitude of migration—This is very much marked in the species living in the Himalayas. In winter high elevation birds descend to the lower altitudes by the exigeg-cies of weather and the descending snow line. With the return of spring, when the snow melts and the snow line receeds upwards, they ascend to breed in higher hills. There altitudinal movements are indulged in, also species, resident at lower altitudes.

4. *Velocity and altitude of migratory flight*. The average speed of ducks and geese is between 40 and 50 miles per hour; under favourable weather conditions it may reach upto 55 to 60 M.P.H. A Birds' flight, day and night, ranges from 6 to 11 hours—*wood cock* 250 to 300 miles; Plover 550 miles in 11 hours.

Eastern Golden Plover—takes a non stop flight of 2000 miles across the sea— *snipe* takes a non-stop flight of 3000 miles—and *wood cock* covers a distance of 1500 miles in a single hop.

Migratory birds fly under 1300 feet and very rarely 3000 ft. above the ground. *Donald* has observed large number of geese crossing Himalayas between 10,000 and 16,000 ft. elevation and *Cranes* and *Storks* flying at about 2000 ft. over the range.

World's Oldest Fossil Flea

A fossilised flea was unearthed recently at Koonwarra in southern Gippsland, Victoria. It is about 120,000,000 years old; that is, about 80,000,000 years older than other fossil fleas that have been found in other parts of the world. Human fossils date back to less than 2,000,000 years.

The flea, excellently preserved in silt stone, was found by Monash University scientists while they were scarching for fossil fish.

The Koonwarra flea is very different from today's fleas and it lived in a very different Gippsland. Although the abdomen and genitalia resemble those of modern male fleas, it has much longer feelers on its head, longer and differently bristled legs and a slightly longer body than its existing counterpart.

It lived near a shallow, fresh water lake not far from a range of high mountains that were possibly snow capped in those far-off times. The ground in the area was mainly bare because grasses had not evolved at that stage. Ferns were widespread, however, and the dominant tree was the gingko rather than the eucalypt of today.

The nut-bearing gingko tree no longer grows in a natural habitat anywhere in the world but in recent millenia it has been preserved and cultivated in Chinese monastery gardens and specimens have been replanted all over the world.

The Koonwarra flea's long thin legs suggest that it lived on the outer surface of a sparsely-haired animal unlike today's fleas which burrow through their hosts fur. The long feelers on the head support this view. Modern fleas have much shorter feelers which do not impede burrowing through thick fur.

If the Koonwarra flea did not burrow, its host's fur must have been short or sparse so that the flea's mouthparts could reach the skin to feed.

No direct evidence has been found of any furred animals living in Australia more than 30,000,CCO years ago but the discovery of the Koonwarra flea provides indirect

evidence that they roamed Gippsland 120,000,000 years ago. There could not have been grazing animals like kangaroos or wallabies because there was no grass to eat. Probably they were marsupials that ate insects, earthworms and roots and possibly were the predecessors of the modern bandicoot.

Only two fossil fleas have been discovered previously, both of them near the Baltic Sea. Their age was put at about 40,000,000 years and their anatomical structure was quite modern. The Koonwarra flea had apparently fallen off its host, drowned in the lake, floated to the edge and then settled into the sediment which built up eventually forming the siltstone that preserved it.

Researchers Find Migraine Clue

Medical researchers at the Prince Henry Hospital, Malabar, near Sydney, Australia, have made a discovery about migraine headache which could lead to more effective treatment of that distressing condition.

The Sydney research team has been studying migraine since 1963. The most important findings concern changes in the level of certain blood constituents during attacks.

Migraine was associated with the appearance in the blood of an as yet unidentified compound which reduced the level of the normal blood constituent seratonin.

Seratonin is the substance which controls the "tone" or degree of constriction of the blood vessels. When the seratonin level falls the arteries of the head dilate and produce the severe headache characteristic of migraine.

The Sydney neurologists found that the "loss" of seratonin during a migraine attack was similar to that produced by the drug reserpine. They were able to induce migraine in people subject to the condition by injecting reserpine but patients not susceptible to the condition remained unaffected by the injection.

The injection of seratonin relieved and sometimes stopped completely the pain of natural and reserpine-induced migraine.

The Prince Henry Hospital researchers' found a family history of migraine in nearly half the cases studied. However, a definite pattern of inheritance of the condition has not been established.

Doctors call migraine a "let-down headache". It strikes the sufferer when he is relaxed after a hard week's work, or even when he is relaxing on holiday. Although about 20 per cent of the Australian population suffer at least one migraine attack during their lifetime, only 5 per cent have frequent attacks requiring medical attention.

By Courtesy: Australian Information Service, New Delhi.

News and Notes

Secondary School Science Teaching Project

WORK is progressing on the writing of text materials for Class IX in Physics, Chemistry, Biology and Mathematics. Trial editions of Teachers Guide for the following were published during the quarter.

Biology Part I and II Teachers Guide (English)
Physics Parts I and III (English)
Chemistry Part II (English)

The revised syllabus for the different disciplines of Biology, Physics, Chemistry and Mathematics for the middle school was published.

A new Chemistry kit for High School classes has been developed. This will be used as a proto-type and several sets prepared for distribution to the States. The kit contains, besides the necessary glass-ware, chemicals also in small tubes in sufficient quantity for one year.

UNESCO Fellowship Programme

Dr. M.C. Pant returned from his two months stay in the U.S.S.R. He also spent one month in U.K. studying in the Nuffield Project and the Scottish Programme. The other three members of the staff who had gone to USSR on a six-months programme also returned in the 3rd week of March after successfully completing their fellowship; These three members are:

1. Shri R.C. Sharma
2. Dr. B.D. Atreya
3. Shri S.P. Sharma

Mr. Mohinder Singh of the workshop also went on this programme and returned in March.

UNESCO/UNICEF Project

The dialogue between the Central Ministry Team and the following States took place during this period.

1. Andhra Pradesh
2. Mysore
3. *Jammu and Kashmir*
4. Kerala and
5. Union Territory of Delhi.

In the last State, discussions centred only for the primary stage since all the Delhi schools have already adopted the NCERT material for the middle school classes.

Orientation Workshop

An Orientation Workshop for the key-personnel from the States was organized in the Department from March 9 to 18, 1970. Nineteen participants from 12 States took part in this Orientation Programme. Within the short period of nine days a heavy schedule was drawn up and there was discussion in the material of Physics, Chemistry, Biology and Mathematics for all the three classes of the middle school and particularly of

those for class VI. The materials were not only discussed but they were also amply illustrated with demonstration experiments and individual activities. There were four sessions for Biology each lasting three hours—four for Physics and two each for Chemistry and Mathematics. As under the scheme Mathematics is not going to be tried at present. The material was not discussed at length but some brief idea was given on the basis of the materials prepared and the structure of the same. The last two days namely 17th and 18th were devoted to general discussion for developing an outline of courses for the two-months course in the States to be organized by them for the science teachers of different disciplines. They have to train the science teachers during this period in the new materials so that they could go and handle the same in the experimental schools within the States. A general programme and syllabus was drawn up for these summer courses. Some of the partieipants were of the view that instead of having a two months summer course there should be two summer courses of one-month duration each. It was left to the States to organize the eourses as best as their resources could allow them, but it was the concensus of opinion that the Course should not be for less than six weeks. The workshop was inaugurated on the first day by Prof. J.K. Shukla, Joint Director. The Valedictory Address was given by Professor S.V.C. Aiya, Director on 18th March. At the first meeting Shri N.K. Sanyal briefly gave an outline of the Project and at the concluding session he told the participants how to organize the Summer Courses and how they could draw upon the assistance from the Science Department staff and the UNESCO experts.

The participants were all supplied with a complete set of publieations in all the subjects and they were also given bromide prints of the Class III Textbook figures which they could utilise for making blocks for their editions in regional languages.

Visit to the States (A.P.)

Some members of the Department namely Shri K.J. Khurana, Shri S. Doraiswami visited the Andhra Pradesh and worked with the Working Groups of the State Council of Educational Research and Training in reviewing their manuscripts for Class VI and VII in Physies and Biology. Dr. L.V. Levehuk, Unesco Expert also visited Andhra Pradesh and worked with the Chemistry Group. He also exhibited the Chemistry Kit to the persons.

In the Biology Group Shri S. Doraiswami stressed on the necessity to follow the structure evolved in the NCERT materials if these were to be adopted by the State. Andhra Pradesh had earlier made a slight departure in stopping the teaching of Botany midway in Class VI and doing part of Zoology in the same class. In the VIIth class they were doing rest of the Botany and Zoology and the whole of Human physiology. All the suggestion of Shri S. Doraiswami the pattern of the NCERT books was restored.

Kerala—The same Team of two members from Department of Science Education and the UNESCO expert visited Kerala in the middle of February and worked with the staff members of the State Institute of Science. They diseussed the syllabus for the Classes VIII, IX and X of the Kerala State Science Programme. The State wanted to introduce the new materials in all the classes simultaneously. This was not supported by the Members from NCERT who said that there ought to be introduction of the material in gradual steps from year to year. Finally the State Institute of Science agreed to this proposal and will be making a recommendation to their Government to introduce the

programme in successive stages spreading over three years.

National Science Talent Search Scheme

The Aptitude Test and the Essay Test of the Examination under the National Science Talent Search Scheme was held all over India at 350 centres on January 4, 1970. The examination was conducted in all the 14 regional languages. About 8,000 students appeared in the examination. The scripts are being evaluated.

Steps are being taken to organize 19 Summer Schools for the Science Talent Search Awardees during May/June 1970. These Summer Schools are for the Under-Graduate level Awardees. Besides these, arrangements are being made for the Summer Programme of Awardees at the Post Graduate level.

The interview for selected candidates for those who appeared at the examination will be held during the month of May.

A booklet entitled Scientific Projects by N.S.T.S. Scholars 1968 was brought out during this period. Another publication "Bhavi Vigyanikon Dwara Nibandh" is under print.

School Science

Two issues of the School Science namely September 1969 and December 1969 were under print. The September 1969 issue has been published and the December 1969 issue would be published in a few days. They contain the articles under the usual features with a great emphasis of work that is being done in the Department and in the country.

Department of Textbooks—The Department of textbooks organized two workshops in Physics and Biology regarding the criteria for textbooks and for evaluation of the textbooks. In the first week Shri K.J. Khurana and Shri S. Doraiswami participated in the Physics and Biology Groups and in the second week Shri K.J. Khurana and Shri G. Raju participated in Physics and Biology respectively.

Department of Teacher Education—This Department organized a seminar for the preparation of curriculum guides. Representatives of State had come to be oriented towards these methods. Shri R.C. Saxena in the Mathematics Group and Shri K.S. Bhandari in the Chemistry Group participated in this workshop.

Central Science Workshop

I. DEVELOPMENT OF PROTOTYPES

Prototypes for class VIII Physics in the field of optics and electricity and magnetism were further modified and improved. A smoke chamber enabling all the experiments to be performed in optics was finalised. The unique feature of this smoke chamber is that it operates on electric power as well as on solar energy. Bright rays of sun are diverted to fall upon the smoke chamber with the help of two reflecting mirrors. The result is excellent and even better than the effect of electricity itself. Further improvements have been effected in the design of electric motor, electric generator, electroscope etc., etc.,

Designs of items required for the general science kit were also finalised. 50 such prototypes have been produced so far. These designs are still being improved.

A few items of class IX Physics have also been developed. It is expected that the entire kit would be developed within 6 month's time.

A Chemistry kit for classes VII, VIII, IX and X has also been developed. The special feature of this kit is that it is very light and compact. All the essential chemicals are provided in the small plastic con-

tainers and other items are suitably placed inside. The proto-types have been sent to D.S.E. for try-outs and finalisation.

II. PRODUCTION

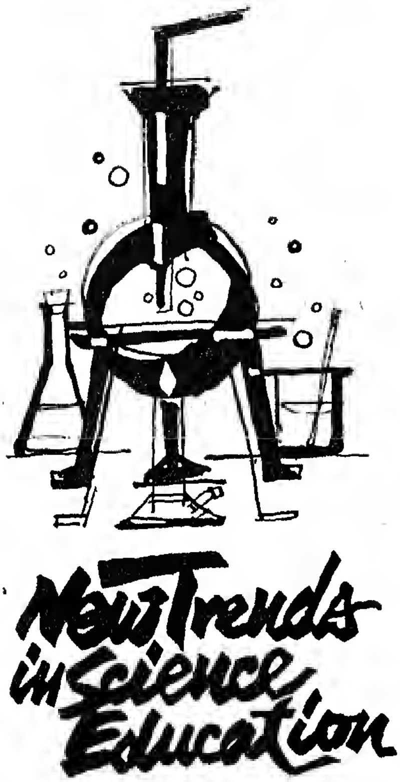
Ninety per cent work of the production of 500 kits for Class VI Physics was completed. 250 kits for Class VI Biology were completed. Another batch of 500 Biology kits is now almost complete. Production of 250 kits each for Biology and Mathematics for class VII was undertaken and 80 per cent work has almost been complete.

III. CENTRAL ACTIVITIES

1. Two more apprentices undergoing training under the Apprenticeship Act 1961 also completed their training.
2. Purchase Section has been extremely busy. To copy with the increased load of work part of the work was transferred to the Workshop Accountant and the cash purchase involving Rs. 30,000 was transferred to Incharge, C.S.W.
3. Shri Virender Kumar, Incharge, Foundry Section was deputed for 3 month's course in Foundry Practice I.I.T., Kharagpur on 5th February 1970.

SUMMER SCHOOLS FOR SCIENCE TALENT AWARDEES MAY-JUNE 1970

Subject	I Year		II Year		III Year	
Physics	Dr. N.N.Sen, Deptt. of Physics, Birla Institute of Technology, and Science, Pilani (Raj.)	15th May to 13th June	Dr. M.S. Sodha, Head of the Physics Deptt. Indian Institute of Technology, Hauz Khas, New Delhi-29	4th May to 2nd June	Dr. J. Mahanty, Head, Physics Deptt. Indian Institute of Technology, KANPUR	
	Prof. B.G. Gokhale, Head of the Physics Deptt., Lucknow University, Lucknow (U.P.)	Dates will be told by the Director	Prof. B. Dayal, Hd. of the Physics, Deptt. Banaras Hindu University, Varanasi (U.P.)	1st June to 30th June	Prof. R.P. Singh, Head of the Physics Department, Indian Institute of Technology, Powai, BOMBAY-76	8th May to 6th June
	Dr. V.S. Bhatia, Physics Department. University of Punjab, Chandigarh	15th May to 13th June			Dr. K.N. Kuchela, Head of the Deptt. of Physics, Bangalore University Bangalore	15th May to 13th June
Chemistry	Prof. R.C. Paul, Head of Chemistry Deptt. Punjab University, Chandigarh	Date will be told by the Director	Dr. V.K. Phansalkar, Deptt. of Chemistry, Poona University, Poona (Maharashtra)	1st May to 30th June	Dr. R.P.Mitra, Head of the Chem. Deptt., University of Delhi, DELHI	15th May to 13th June
	Prof. R.C. Kapoor, Chemistry Deptt., Jodhpur University, Jodhpur	11th May to 9th June			Dr. A.K. Gayan, Head, Deptt. of Maths & Statistics, Indian Institute of Technology, Kharagpur (W.B.)	15th May to 13th June
Maths.	Prof. M.P. Singh, Head of the Deptt., of Math. I.I.T. Hauz Khas, NEW DELHI-16	18th May to 16th June	Dr. H.N. Rawal, Head of Deptt. of Maths, Gujarat University, AHMEDABAD	15th May to 13th June		
Biology	Prof. B.R. Seshachar, Head of the Zoology Deptt., University of Delhi, DELHI	15th May to 13th June	Pro. P.N. Mehra, Head of the Botany Deptt. University of Punjab CHANDIGARH	Dates will be communicated by the Director	Prof. A. Abraham, Head of the Deptt. of Botany, Kerala University, Trivandram.	15th May to 13th June



Summer Institute Programme

IN the scheme of reorienting science education, the science teacher occupies a central position. The summer institutes are being organised with a view to creating such opportunities by bringing together groups of science teachers in a university or college campus for a period of about six weeks during the summer vacation, and making available to them modern textbooks, improved laboratory techniques and teaching aids, under the supervision of competent instructions.

Summer Science Institute (1963-1969)

During the period 1963-69, the University Grants Commission, in collaboration with the National Council of Educational Research and Training and United States Agency for International Development/ National Science Foundation, organised at various universities 293 summer institutes in science and mathematics for teachers from high/higher secondary schools/PUC!Intermediate colleges attended by nearly 11200 teachers in mathematics, physics. chemistry and biology. The number of institutes held during the period and the enrolment at the institutes are given below:

Year	No. of participants				Total
	Mathematics	Physics	Chemistry	Biology	
1963	34(1)	43(1)	38(1)	39(1)	154(4)
1964	169(4)	170(4)	148(4)	153(4)	640(16)
1965	616(16)	488(13)	464(13)	261(7)	1829(49)
1966	490(12)	468(12)	410(11)	308(8)	1676(43)
1967	747(15)	572(16)	580(16)	482(13)	23381(60)
1968	646(15)	594(17)	612(16)	450(13)	2302(61)
1969	600(16)	551(14)	734(18)	436(12)	2321(60)*
Total	3302(79)	2886(68)	2986(79)	2129(58)	11303(293)

Figures in brackets indicate the number of institutes held)

Programme for 1970

During 1970, it is proposed to organise 56 summer institutes under the above programme; for teachers from secondary schools, colleges (teaching PUC/intermediate classes) and Training colleges. Biology 9; Chemistry 13; Physics 14, Mathematics 20—total 56.

*Includes 4 institutes, the each in Mathematics' Physics, Chemistry & Biology using Nufleld Materials in Collaboration with the British Council.

Location and Duration of Summer Institutes for 1970

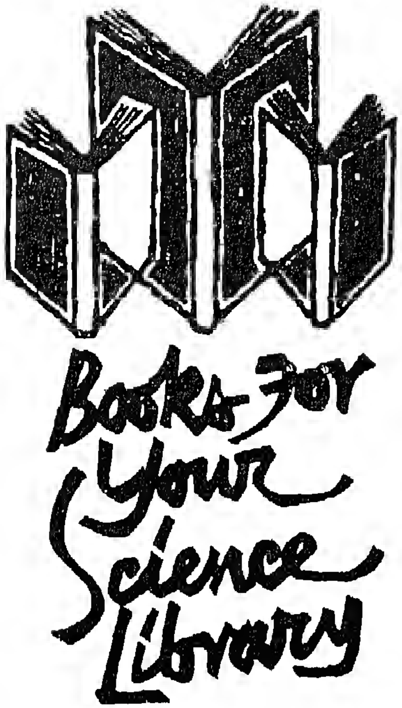
Sl.	University	Institute Dates	For Teachers From	Director & Location
Biology				
1.	Meerut University	18th May-26 June	Assam, Manipur, Nagaland, NEFA, Bihar, West Bengal, Uttar Pradesh	Dr. V.P. Agarwal, Principal, D.A.V. College, Muzaffarnaga
2.	Punjab University	1 June-12 July	Punjab, Haryana, Chandigarh, Himachal Pradesh, Jammu & Kashmir, and Delhi.	Prof. P.N. Mehra, Department of Botany, Punjab University, Chandigai
3.	Indore University	11 May-20 June	Madhya Pradesh	Dr. Ravi Prakash, Principal, Holkar Science College, *Indore.*
4.	Poona University	27 April-6 June	Maharashtra and Goa	Dr. D.D. Wani Department of Botany M.E.S. College, Poona-4.
5.	Rajasthan University	18 May-27 June	Rajasthan	Dr. P.M. Mathur Principal, Govt. College, Ajmer.
6.	Sardar Patel University	5 May-14 June	Gujarat	Prof. J.J. Shah, Department of Botany, Sardar Patel University, Vallabh Vidyanagar.
7.	Marathwada University	1 May-11 June	Maharashtra	Prof. A.L. Lohgaonker, Department of Zoolog Yashwant Mahavidyalaya, Nanded.
8.	Kerala University	20 April-30 May	Kerala, Minicoy, Laccadive and Amindive Islands and Mysore	Dr. O.M. Mathen Department of Botany, Uni Christian College, Alwaye-2
9.	Madras University	9 May-18 June	Andhra, Orissa, Tamil Nadu, Andaman and Nicobar Islands	Dr. P.J. Sanjeeva Raj Department of Zoology Madras Christian College, Tambaram, Madras-59.
Chemistry				
10.	Gauhati University	25 May-4 July	Assam, Manipur, Tripura, Nagaland, NEFA	Dr. P.K. Talukdar, Department of Chemistry Cotton College, Gauhati.
11.	Sambalpur University	12 May-20 June	Orissa and West Bengal	Dr. M.K. Rout, Principal Gangadhar Mehar College Sambalpur (Orissa).
12.	Agra University	11 May-20 June	Uttar Pradesh and Bihar	Dr. S.N. Srivastava, Department of Chemistry, Agra College, Agra.

Sl.	University	Institute Date	For Teachers From	Director & Location
13	Punjab University	1 June-15 July	Chandigarh, Punjab, Haryana, Himachal Pradesh, J & K. and Delhi	Shri B S. Bahal, D.A V. College, Jullundur,
14	Indore University	11 May-20 June	Madhya Pradesh	Dr. S.G. Harmalkar, Chemistry Departmen, Holkar Science College, Indore
15.	Jabalpur University	11 May-20 June	Madhya Pradesh, Rajasthan	Dr S N. Kaveeshwar, Principal, Govt Science College, Jabalpur.
16	Nagpur University	4 May-13 June	Vidarbha Region	Prof. N.V. Karbelkar, Department of Chemistry, Vidarbha Mahavidhyalaya, Amravati
17	Gujarat University	4 May-14 June	Western Maharashtra, Goa and Ahmedabad	Dr. A M Trivedi, Department of Chemistry, Gujarat University, Ahmedabad
18	Sardar Patel University	5 May 14 June	Gujarat	Dr M.C Pant, R.P T P. Science College, Vallabha Vidyanagar, Via Anand (Dist. Kira)
19	Regional College of Education, Bhopal	5 May-14 June	Special Institute for Training College Teachers (All India)	Dr. G S. Tiwari Department of Chemistry, Regional College of Educationa, Bhopal
20	Andhra University	15 May-22 June	Andhra Pradesh and Mysore	Prof M.N. Sastri, Department of Chemistry Andhra University, Waltair.
21.	Annamalai University	27 April-6 June	Tamil Nadu, Andaman and Nicobar Island, Kerala	Ds. J K Ganapathy, Department of Chemistry Annamalai University, Annamalainagar.
22.	Madras University	4 May-13 June	Special Institute (with NCERT materials)	Pro. L M. Yeddanapall, Chemistry Department Loyola College, Madras
	Mathematics			
23.	Gauhati University	8 June-18 July	Assam, Manipur, Tripura, NEFA and Nagaland	Prof. M.N. Barua, Department of Mathematics, Gauhati University, Gauhati.
24.	Sambalpur University	11 May-20 June	Orissa and Eastern Madhya Pradesh	Dr M.M Nanda, Gangadhar Mehra College, Sambalpur, Orissa

Sl No	University	Institute Dates	For Teachers From	Director & Location
25	Utkal University	11 May-20 June	West Bengal and Orissa	Prof B Misra, Ravenshaw College, Cuttack.
26	Kashmir University	20 May-30 June	Kashmir	Prof. Jan Mohammad, Department of Mathematics, Kashmir University, Srinagar.
27	Jammu University	9 May-19 June	Jammu and Himachal Pradesh	Pro M R Puri, Department of Mathematics, Jammu University, Jammu.
28	Agra University	25 May-5 July	Western U.P	Dr H.C Sinha, Bareilly College, Barielly
29	Allahabad University	25 May-5 July	Eastern U P and Bihar	Prof N N Bhattacharya, Ewing Christian College, Allahabad.
30	Delhi University	4 May-13 June	All India Sequential	Principal P D. Gupta, Ramjas College, Delhi
31.	I I.T	11 May-21 June	Delhi	Pro. M P. Singh, Department of Mathematics, Indian Institute of Technology, Delhi.
32	Punjab University	18 May-27 June	Punjab, Haryana, and Chandigarh.	Princiapl C L Arora, D A.V. College, Amritsar.
33.	Bombay University	22 April-2 June	Western Maharashtra	Shri H.K. Shama Iyengar, S S & L S Patkar, College, Goregaon (West) Bombay-62.
34.	M S University of Baroda	27 April-6 June	Gujarat, & Western M.P.	Shri C C. Shah, Department of Mathematics, M.S University of Baroda, Baroda
35.	Marathwada University	5 May-14 June	Marathwada University and Andhra Pradesh	Shri D V. Koranne, Department of Mathematics, S B E.S College, Aurangabad
36.	Poona University	27 April-31 May	Vidarbha and Goa	Principal N R. Kulkarni, R K. Talreja College, Ulhasnagar
37	Poona University	27 April-6 June	Konken area	Principal R T Kulkarni, JSM College, Alibagh.
38	Sardar Patel University	1 May-10 June	Gujarat	Principal N. D Desai, R.P.T P. Science College, Vallabh Vidyanagar

Sl	University	Institute Date	For Teachers From	Director & Location
39	Ravishankar University	11 May-21 June	Madhya Pradesh	Dr C.B L. Verma, Government Science College, Raipur (M P.)
40.	Rajasthan University	20 May-30 June	Rajasthan	Prof. G.C. Patni, Department of Mathematics, Rajasthan University, Jaipur
41	Kerala University	16 April 28 May	Kerala, Minicoy, Laccadive, Amindive Islands, Tamil Nadu Andaman and Nicobar Islands.	Dr S Parameswaran UniversityCollege,Trivandrum
42.	Mysore University	3 May 13 June	Mysore	Shri B V. Achar, M G M College, Udipi (Mysore).
Physics				
43.	Gauhati University	25 May-4 July	Assam, Manipur, Tripura, Nagaland and NEFA	Dr. H Goswami, Department of Physics, Cotton College, Gauhati.
44	Utkal University	18 May-27 June	Orissa and West Bengal	Dr. Harihar Misra Revenshaw College, Cuttack-3.
45	Bhagalpur University	18 May-27 June	Bihar and Uttar Pradesh	Principal S P. Sinha, T.N B. College, Bhagalpur.
46	Kurukshetra University	11 May 20 June	Panjab, Haryana, Himachal Pradesh, Chandigarh, & Delhi	Dr. K K. Nagpal, Department of Physics, Kurukshetra University, Kurukshetra
47	Bombay University	4 May-13 June	Greater Bombay	Shri G K. Desai, Department of Physics, Kishanchand and Chela Ram College, Bombay-20.
48	Poona University	4 May 13 June	Maharashtra and Goa	Shri D.V Bauve Furgusson College, Poona.
49.	Indore University	11 May-20 June	Madhya Pradesh	Prof. R.G. Nigeskar, Holkar Science College, Indore.
50	Sardar Patel University	27 April-6 June	Gujarat	Prof. A.R. Patel, Department of Physics, Sardar Patel University, Vallabh Vidyanagar.
51.	Jodhpur University	7 May-17 June	Rajasthan	Pro G L. Gupta, Department of Physics, Jodhpur University, Jodhpur.

Sl.	University	Instiute Date	For Teachers From	Director æ Location
52.	Kerala University	20 April- 30 May	Kerala, Laccadive, Minicoy and Amindive Islands	Prof. R B. Thomas, Union Christian College, Alwaye.
53.	Madras University	4 May 13 June	Tamil Nadu, Andaman and Nicobar Islands and Mysore.	Shri S. Sundararajan, Department of Physics, Voorhees College, Vellore, Tamil Nadu.
54.	Andhra University	18 May 27 June	Andhra Pradesh	Dr D. Premaswarup, P.G. Centre of Andhra University Guntur,
55.	Madras University	20 April- 30 May	Tamil Nadu	Dr G A. Savariraj, St Joseph's College, Tiruchirapalli.
56	Regional College of Education Mysore	1 May 10 June	Preparation of Instructional Methods for Secondary Schools in Southern Zone	Dr. V.R. Rao, Regional College of Education, Mysore.



Fundamentals of Heat (for degree classes)

D.S. MATHUR, SULTAN CHAND & SONS
Delhi, (Second Edition), 1969.

THE book is a voluminous (810 pages) one codifying a lot of information on the subject. But the general plan and pattern followed in the book is rather old fashioned. About 50 per cent of the material covered in this book must find its rightful place in a good higher secondary text. The major portions of the chapters on Thermometery, Calorimetry, Expansion, Transference of heat, etc., are definitely not to be dealt at this length and detail in a book meant to be used at the degree level. The author finds immense pleasure in describing experiments after experiments just illustrating the same physical principle. For example, there are about twelve different experiments described for the determination of the coefficients of thermal expansion of isotropic solids. A similar spate of experiments could be pointed out in Calorimetry, Mechanical Equivalence of heat etc. It is high time for our authors to follow the new trends in Science teaching, and modify the textbook writing accordingly. Portions like Kinetic theory, Thermodynamics, Radiation, Statistics, etc., are the real areas where the author could have tried to do more justice, in a text book intended for degree classes. Modern views, regarding specific heat are compressed in two pages, whereas more useful work could have been done through kinetic theory and elementary ideas of quantum theory. More modern ideas and details could have been given to low temperature physics instead of describing all classical experiments and refrigerators. Similarly it would have been very desirable to include a chapter on infrared radiations and its experimental study. More vivid and lucid treatment is needed for the chapter on Radiation.

As it is, the book can be treated as a 'source book' for the higher Secondary and pre-university level and therefore suggested for the senior school libraries for the same purpose.

T.N.R K. KURUP

MARCH—JUNE 1970

particulars about School Science

1.	Name of publication	School Science
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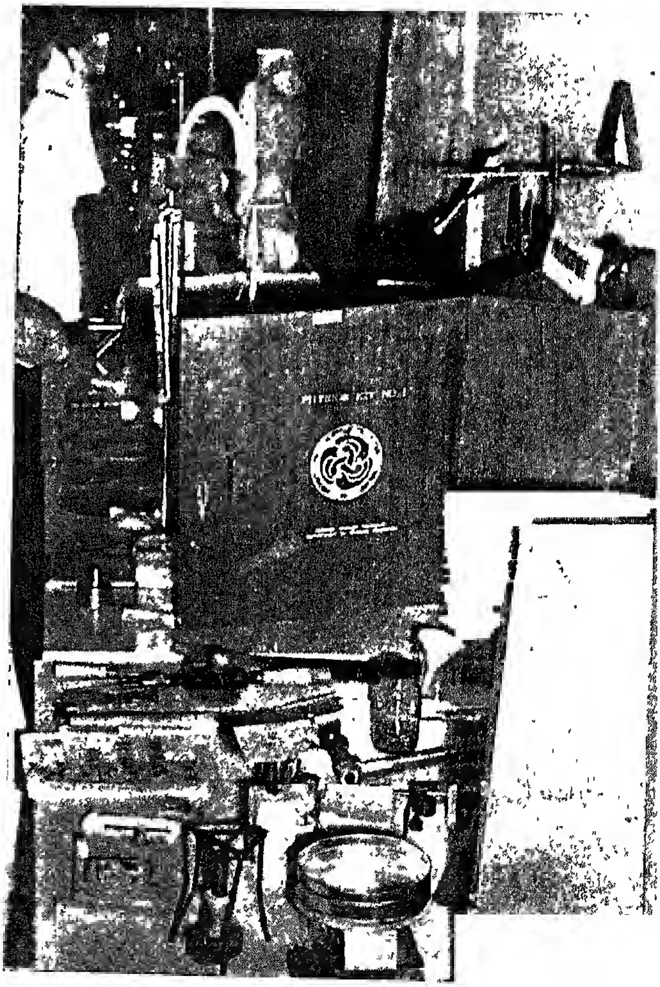

A view of the Science Kits prepared by the Department of Science Education, NCERT

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAININ

SCHOOL SCIENCE QUARTERLY

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TO OUR CONTRIBUTORS

School Science is a quarterly journal intended to serve teachers and students in schools with the most recent developments in science and science methodology. It aims to serve as a forum for exchange of experience in science education and science projects.

Articles covering these aims and objectives are invited.

Manuscripts, including legends for illustrations, charts, graphs, etc., should be neatly typed, double spaced on uniformly sized paper, and sent to the Editor, School Science, Department of Science Education, NIE Buildings, Sri Aurobindo Marg, New Delhi 16. Each article may not normally exceed 10 typed pages.

The articles sent for publication should be exclusive for this journal Digests of previously published articles modified to suit the scope and purpose of **School Science** will be accepted. In these cases the name of the journal in which the original article appeared must be stated.

Headings should not be underlined.

Selected references to literature arranged alphabetically according to the author's name may be given at the end of the article, wherever possible. Each reference should contain the name of the author (with initials), the title of the publication, the name of the publisher, the place of publication, the volume and page numbers.

In the text, the reference should be indicated by the author's name followed by the year of publication enclosed in brackets, *e g*., (Passow, 1962). When the author's name occurs in the text, the year of publication alone need be given in brackets, *e.g.*, Passow (1962).

Illustrations may be limited to the minimum considered necessary, and should be made with pen and indelible Indian ink Photographs should be on glossy paper, at least of post-card size, and should be sent properly packed so as to avoid damage in transit.

Letters to the Editor

THIS note deals with the corrosion resistance quality of the famous Iron Pillar of Delhi In spite of its exposure to all kinds of weather, rough and mild, humid and dry, for centuries, the Iron Pillar is still going strong without any signs of rust or decay. In my article 'Iron Pillar of Delhi' SCHOOL SCIENCE, 1963, Volume 2, Number 2, I had discussed this problem—seemingly a paradox—and quoted analyses of the substance of the Pillar and investigations made by different scientists in pursuit of an answer to this riddle.

But since I wrote the above article there has appeared some more literature on the subject which I feel I should bring to the notice of the readers Investigations into the nature of the metal of the Iron Pillar of Delhi were made by W E. Bardgett, Consultant, Research and Development Department, The United Steel Companies Ltd., U K. and J.F. Stanners, Head of Corrosion Research, British Iron and Steel Research Association, U K. Bardgett came all the way from U.K. to examine the pillar on the spot, and they wrote a lengthy article about their findings in the journal of British Iron and Steel Research This article has been reproduced in the *National Metallurgical Laboratory Technical Journal* published by the Council of Scientific and Industrial Research, Government of India. In fact CSIR brought out a special 'Delhi Iron Pillar Number' of this journal, Volume V, Number 1, in February 1963.

Though there is no wide departure in there findings from what has already been published in my article referred to above, yet I feel it would make quite an interesting and informative reading particularly to those that would like to be kept posted with the latest on this theme.

This special 'Delhi Iron Pillar Number' also contains another significant article on the same topic by M. K. Ghosh He raises quite a few new points of interest We also find observations On Corrosion-resistance of Ancient Delhi Iron Pillar in another article in the same journal by A.K. Lahiri, T. Banerjee and B.R. Nijhawan. These authors have also analysed and experimented on the iron prepared by Adivasis of Central India by their own primitive methods. It is interesting to note in their findings that iron prepared by Adivasis compares so well with the iron of Iron Pillar in its corrosion resistance quality.

U. S. NIGAMA

Environmental Education in the Curricula of Indian Schools

S. DORAISWAMI
Department of Science Education, National Council of Educational Research and Training New Delhi

THE recent 10th General Assembly and Technical Meeting of the International Union for Conservation of Nature and Natural Resources held in Delhi brought into focus the urgency and necessity to emphasize conservation education in our school curricula. The preliminary Working Meeting on "Environmental Conservation Education Problems in India" discussed at length the problems of environmental conservation education at different levels in India (NEWSLETTER, Commission on Education, IUCN No 3 January/March 1970) Several background papers were presented by Indian specialists particularly one by the author on the "Problems of Conservation of Nature in the School Curriculum in India" The meeting passed a number of resolutions whose main objective was that conservation education should be a part of the curriculum of our schools. It was also stressed that the teaching of biology and other subjects should be ecologically oriented The term "environmental conservation education" is meant to be more comprehensive than mere conservation education.

What is the nature of this environmental education? Cerovsky (1970) has stated that by environmental education is meant that education which aims at creating the correct approach of man to his "natural environment" in the sense of conservation, wise use, and management An ecological thinking is the basic feature of this approach and consequently of environmental education The term "conservation" at once brings to the mind the conservation of soil, water, the mineral resources, and preservation of species of fauna and flora. Perhaps it will also include concepts about pollution, balance in nature, etc But the term "environmental education" means also the social behaviour of man Environmental education aims at producing citizens who are aware of their biological and physical environment and their problems, and at least know how to solve them.

For environmental education to achieve the greatest impact it must (1) provide factual information leading to an understanding of the total bio-physical environment, (2) develop a concern for environmental quality; (3) inform citizens as to how they can play an effective role in achieving the goals derived from their attitudes.

Paper read at the "International Working Meeting on Environmental Education in the School Curriculum" held as part of the UNESCO's INTERNATIONAL EDUCATION YEAR in cooperation with UNESCO at Foresta Institute for Ocean and Mountain Studies at Carson City, Nevada, U S A from June 20—July 10 Published with the permission of the International Union for Conservation of Nature and Natural Resources.

The rapid industrial and allied developments that have taken place in our country, since the days of independence, and the rapid rate of urbanization of rural areas have led to the extinction of many species of fauna and flowering species of flora, this situation has increased with the coming into being of numerous hydro-electric and similar projects all over the country, and the pushing away further of the natural jungle barriers due to large scale and, to a large extent, well-intentioned but arbitrarily chosen plans for requisition of land to be utilized for these projects Added to all this the uncertainty of the monsoon and the diverting of all available sources of water to food production have made inroads into what was once a luxurious natural biome in many parts of India. In such a context it is not surprising that many Indian children are not aware today of the vast potential, both of animals and plants in our country. The gradual disappearance of animals which were once well known in this country like the cheeta, the black buck, the rhinoceros, the tiger and even the lion is an eye-opener Intensive measures undertaken by various agencies to promote the increase in the vegetative cover of the land and conservation of wild life have had very little impact on the minds of younger children.

In the rural areas, excepting in some industrial regions, the bulk of the population is engaged in agriculture. The raising of crops still proceeds according to the old traditional methods, but with the extension of the impact of agricultural research the farmers are slowly getting enlightened and are adopting modern methods of cultivation Still many acts of the rural folk show that they are not even aware of the impact of the human society on the balance in nature, for example, the thoughtless destruction of plants and animals, removal of green cover from areas, the cutting of barks from avenue trees and the burning of cow-dung as fuel which could otherwise be used as manure to enrich the soil.

Man is specially responsible to develop methods and techniques to use the resources of nature rationally. Conservation education to be effective must be given to members of the population and it is best begun when they are young and in schools. This paper describes an analysis of aspects of environmental education included in the curricula of Indian schools, and also gives some areas and concepts introduced in the new curricular materials prepared at the Department of Science Education in the National Council of Educational Research and Training. These materials have already been tried for three years in Delhi, and this year they are to be tried in many other States on an experimental basis All the States of India are beginning to reform their curriculum in science and it is but opportune that we emphasize the need for environmental education and strive for the inclusion of ideas about conservation of nature and man's duty to protect the same if he is to survive. Some of the observations made here and the conclusions drawn are bound to be helpful in the objectives of achieving environmental education

Present Position

Textbooks and curricular materials used in schools till now have been on traditional lines. Those in biology followed the taxonomy-morphology approach and there was a lot of factual material which is considered now as dead-weed. Only recently there have been attempts at the revision of science curricula in the various States of India

The structure of education in India is diverse: each State following one pattern,

since education is purely a State subject. Science is being taught as general science, elementary science or as science at various stages. These are 18 States and 10 Union Territories in India. The patterns of education are as many as these. The primary stage of the school is generally from Classes I-V; the upper primary or middle school VI-VIII and the high or higher secondary school IX and X/XI. The age of the pupil is 5 + when he joins the school

In the face of such a diversity the Education Commission was set up to recommend national goals in education and frame a pattern of education which could be followed by all States. In its report (*Education Commission Report* 1964-66) it has emphasized the direct link between education, national development and prosperity and this according to the Commission could exit only when the national system of education is properly organized. While making recommendations for an educational revolution it has kept in view the aspect of internal transformation so as to relate it to the life, needs and aspirations of the nation.

Further, the Commission has said that the quality of science teaching has to be raised considerably so as to achieve its objectives and purposes, namely, to promote a deeper understanding of basic principles to develop problem-solving, analytical skills and the ability to apply them to the problems of environment and social living and to promote the spirit of inquiry and experimentation.

The pattern of schooling recommended by the Commission is:

Primary stage	—Classes I-IV
Middle or Upper Primary stage	—Classes V-VII
High school stage	—Classes VIII-X

This is to be followed by a two-year junior college course and then a three-year degree course. Science is to be taught to all the pupils up to the end of their schooling, as a part of general education By and large, many of the States have begun to adopt this pattern, though a few are following their own.

Why Teach Science?

The aims of teaching science at the primary stage should be to develop a proper understanding of the main facts, concepts, principles and processes in the physical and biological environment. Particularly in the lower primary classes the focus should be on the child's environment—social, physical and biological The study in Classes III and IV should include areas of science such as the plants and animals in his surroundings, the air he breathes, the water he drinks, the weather he lives in, the earth he lives on, his body and the heavenly objects he looks on at night. School gardening is also important as it provides the pupils with direct and valuable experiences of natural phenomena.

At the higher primary stage the emphasis may shift to the acquisition of knowledge with the ability to think logically, to draw conclusions and to make decisions Science at this stage should be taught as physics, chemistry and biology, i.e , as separate disciplines.

Modern Trends in Science Teaching

Formerly, a general science approach to the teaching of science was widely adopted at the elementary stage. This has not proved successful, as it tended to make science appear formless and without structure, and ran counter to its methodology. A disciplinary approach to science learning would be more effective in providing the necessary science base to young people.

In secondary schools in the rural areas, the linking of education to agricultural environment can be done through integrated courses which bring out the impact of physical science on biology.

To the young child, the world is all in one piece He observes what is happening in the environment. So the syllabus as well as the teaching of science in the primary school, is environment based. If the child is to grasp the true meaning of science, he must be involved personally in seeing and solving the problems of his own life. This can only result from a direct acquaintance with science from his earliest school years. The purpose of the syllabus is to make the child participate actively in the learning experiences in the class-room. There is greater emphasis on the "process" of science rather than on the "product" of science. The "process" of science, among other things, includes the role and function of science in improving the standards of living, the country's agriculture, health, industry, communication and transportation, and in preservation of nature and the rational use of natural resources.

New Curriculum

The foregoing gives the general approach to the framing of the syllabus in science teaching in general. While preparing the syllabus for general science, the objectives of teaching science that were set out were:

to acquire knowledge of

(a) biological environment
(b) physical environment
(c) material environment including forces of nature and simple natural phenomena;

to develop appreciations such as

(a) impact of science on life
(b) contributions of scientists
(c) the vastness of space
(d) the limitlessness of time
(e) simple natural phenomena
(f) interdependence of life (plants and animals)
(g) dependence of living things on physical environment and adaptation
(h) modification of environment by living things

The last three or four of the above would indicate the nature of the environmental study of science In the pages to follow are described the main features of the syllabus and text materials prepared for adoption by different states The parts dealing with biology are particularly stressed

Science at Primary Stage

There are eleven units included in the syllabus of the primary school science. These are:

Section I · Earth related sciences:

1. Our universe 2. Air, water and weather 3 Rocks, soils and minerals.

Section II : The physical sciences:

4. Energy and work 5. Matter and materials 6 Housing and clothing.

Section III : The biological sciences·

7 Living things 8 Plant life 9. Animal life 10. The human body, health and hygiene 11. Safety and first aid.

The arrangement of units is logical but it does not represent the way the children learn them, or develop interest in their environment.

Each class textbook (prepared for class III and upwards only) includes matters of some or all units under each of these three sections. In his earliest years the child should learn about things that are close to him, around the home, the school, the garden,

the field, the neighbourhood and the nature surrounding these Gradually with increasing age, his horizon widens to include the community, the village, district, state, the country and the world Throughout his early impressionable years a child's study of science should give him an understanding of how to make life richer, safer, happier and more productive for himself and for society.

Under each unit of study a number of major and minor concepts have been listed as a core for the development of scientific understanding of the environment. Science is also a set of attitudes about doing and thinking—and appreciation of the natural and man made environment.

Science is fast changing conditions in the environment. The modern world is very different from what it was one generation ago. The children feel the impact of the progress that science has brought about. They use more and more plastic-ware, synthetic fibres, and drugs which were unknown to their parents when they were young. They are affected by new means of communication (telegraph, radio, cinema); by better methods of transport, by fertilizers and hybrid seeds for better crops, by irrigation and improved methods of farming, by new standards of sanitation. They are also brought face to face with problems of population control and conservation of nature. A child growing up in this changing environment has to learn about these new features of the same.

Most of what the children learn until they are three or four years old is learnt strictly through observation and experience. The concept of erosion is introduced when dealing with rocks, soils and minerals (unit-3) The children are helped to realize that rocks and stones are fragments from the bed rock They have been broken up (weathered) and have been smoothened off (eroded). These processes are often carried on by running water, wind blown sand and sometimes by the grinding action of glaciers The problem here is to convey to students how weathering breaks rocks into smaller pieces.

In class IV soils are studied on a regional basis. Changes in soil are discussed in reference to the living things which depend on the soil. Erosion and its prevention (conservation) then loom large as social problems. Man tries to check erosion and conserve the soil in his surroundings The teacher should help children to use their knowledge of erosion to think out methods of checking that erosion and conserving soil. This is done in many ways Trees and grass help conserve soil (illustrated by activities). Lack of grass allows soil to be washed away Dams check erosion of soil. Terracing of slopes conserves soil.

Biology at the Middle School

The syllabus for this stage aims at giving the pupils a basic knowledge of the living world surrounding them They need this knowledge in their every-day life and in their work in such occupations as agriculture, health and the medical services. For this reason the relationship of biology to agriculture, human nutrition, health, medicine and problems of family planning are stressed. Wherever the occasion demands, the importance of conservation of nature is stressed. The objective of the course is to give the pupils of the middle school a thorough understanding of the following four aspects of biology:

(1) Familiarity with common, important and interesting groups of plants and animals in their environment and with something of the diversity in the plant and animal kingdoms.

(2) A good understanding of the basic structure and life processes of plants, animals and man

(3) Understanding of the main trends in the evolution of organisms. The need for correct management of plant and animal resources, conservation being a continuing theme. Problems of control of harmful animals are considered

(4) Understanding of the general picture of the living world and man's place in it. The links between man and the plant and animal world are pointed out.

The textbooks prepared have enough material on ecology, the importance of plants and animals and on the development of living things to keep the course in line with modern curriculum trends.

Great care is to be taken in the training of teachers to ensure that the diversity of plants and animals is taught to emphasize an environmental approach to this part of the whole biology course. At the end of the middle school course is included a section "man and his environment" which gives an understanding of the relationships between the living and the non-living world, a simple analysis of the biological events occurring in agricultural fields and a consideration of the way man should learn to control, manage and conserve the resources of his environment

The method of teaching advocated emphasizes experimental and practical work in classes and observations in nature through field excursions. The teacher should introduce the topics in the form of problems and pupils should be helped to find solutions to these The whole programme is based on activity by the pupils as well as by the teacher.

It may perhaps be useful to list the main topics introduced which are of interest to an environmental education. Part I introduces the study of the biology of plants with a narration of the importance of plants in nature and in human affairs The idea of food chains and food webs is also given to emphasize the importance of plants Mention is made of "vanamahotsava", the function that is held every year, when trees are planted and measures taken to protect them. During this period afforestation measures are taken in the forest areas and hills. This period of celebrations in schools helps to create a love for plants in the minds of young pupils and it also tells them how to take care of the plants The chapter on dispersal of fruits and seeds gives an idea of how the species maintain their numbers in nature. The chapter on 'Plants and their environment' gives an elementary account of the ecology of plants and also provides pupils with ideas about the careful and rational use of plants. The last chapter of Part I reveals the diversity of plants and the abounding natural resources of the country. It displays the role of bacteria as decomposers and their part in the recycling of matter in nature. The algae as part of plankton produce oxygen during photosynthesis. It is said that nine-tenths of the oxygen replenishment of atmosphere is by the activity of algae in the plankton. Algae are also important as they constitute the basic link in the food chain and are the primary producers. Lichens are mentioned as pioneers in plant colonization. Their role in the weathering of rocks and the formation of soils is also emphasized. In the same chapter coal is mentioned as a natural resource and its formation is described in brief.

Part II of the text deals with the biology of animals and the interdependence of plants and animals. The need for conser-

vation of animals is mentioned in the opening chapter. The "balance of nature" so well maintained in nature could be disturbed by man's actions. Conservation means not only protection of wild animals but also the obtaining of the maximum number of animals without upsetting the "balance of nature".

After the introductory chapter follow those dealing with the diverse phyla of the animal world. Brief descriptions of a few types in these include their place in the biosphere and the part they play in nature and in human affairs. Thus under Protozoa the role of parasitic forms is described as also the part the unicellular animals play in the food chain as part of the plankton. The part dealing with parasitic worms is important because pupils could be taught methods of prevention and sanitation, necessary particularly in a rural area. Earthworms are described as friends of the farmer. The chapter on insects is very important and here pupils are made familiar with the beneficial and harmful insects, the commercial products of insect life and the methods of insect control by the correct use of DDT and other insecticides. Excessive destruction of insects by indiscriminate use of DDT may decrease the bird population of the area and bring about consequent disturbance of the "balance of nature".

The chapter on "Fish" includes a section on 'Food chain' and the importance of a good planktonic flora and fauna for abundance of fish. Opportunity may be taken to describe the causes of pollution of water which brings about the destruction of fish in large numbers Instances may be cited of natural pollution by way of water blooms, increase of CO_2 content etc., and the pollution caused by man's neglect of the environment like letting in industrial wastes into rivers and lakes, oil leakage from oil tankers and general navigation and the pollution of rivers and water reservoirs brought about by not taking necessary precautions. Then follow the chapters on amphibians, reptiles, birds and mammals. In every chapter the role of that animal community in the particular ecosystem is stressed. The role of birds in keeping down the pest population is described The chapter on mammals includes the diversity of animal life and the richness of the fauna of the country. Some of the animals which are decreasing in numbers are mentioned and the necessity of protecting them in sanctuaries is stressed. Here a good supplementary reading material would be a book on sancturies and national parks.

Part III deals with the biology of man It describes the various organ system and their functions and also the nervous and hormonal regulation of the processes

As stated earlier, the section on "Man and his environment" gives the relationship between the living and non-living world and an account of how man should learn to control, manage and conserve the resources of his environment.

The course in the middle school thus gives the details of the biology of plants, animals and man Based on the concepts learnt here the course in the high school is built around fresh topics common to all living things.

Biology in the High School

The course is presented as a unified programme explaining the main principles of modern biology. The topics dealt with are (a) fundamentals of molecular biology (b) genetics (c) evolution (d) ecology and (e) conservation of nature.

The topic conservation of nature forms an important section of the course. It helps in the analysis of man's relationships with

nature and in a consideration of the ways of maintaining our environment for the future. The normal balance in nature and consequently the guarantee that life will continue to exist on the earth, depends on the understanding of this principle.

The study of ecology vis-a-vis organisms as a whole and as groups in relation to the different environments in this country would highlight the potential natural resources and enable constructive thinking to follow. With this in view the need to conserve such resources as are still left with us, in spite of human encroachment on the natural environment has been emphasized. It should, however, be mentioned that one of the basic aims of the course would be to develop an influence on the mind of the young child to indicate the social implications of biology in relation to everyday human needs, and the nature of present human activities on the life of other organisms and, how far, a study of physiological ecology could bring about a better balance in nature than what exists at present

The curriculum developed by the NCERT fosters an understanding of the interactions between nature and living beings and inculcates in the younger generation the need and the urgency to face the inevitable task of conserving the fast diminishing natural resources, if the balance of nature is not to be seriously upset, and the environment be kept in a state of balance (both in the physiological and ecological aspects).

Implementation of Conservation Education in India

Conservation Education is taking root in Indian schools New textbooks and teachers' guides have been published by the NCERT. The books for the middle school classes are ready and they are being used in about 450 schools in Delhi, and 120 Central Schools all over the country. Besides these some states like Andhra Pradesh, Gujarat, Kerala, Mysore, Manipur and Tamil Nadu have shown interest and have adopted these materials for experimental teaching During this year many states will be trying these books in thirty experimental schools in each state. Work is now in progress on the textbooks and teachers' guides for the high schools. The Study Groups have also completed work on middle school materials which have been published and they are now working on high school materials.

All these efforts give us hope that conservation education in Indian Schools will be practised on a wider scale If this process proceeds more rapidly the majority of children in India will soon have an opportunity to be acquainted with the ideas and the practice of the conservation of Nature. The new generation in about 10-20 years, will be able to prevent destruction of Nature.

If we are to succeed we need coordinated efforts on the part of school educators at all levels in the centre and in the States. Efforts to make an impact of conservation education on the pupils will be effective only when every school teacher and every pupil in the schools in India begins to consider the idea of a careful and rational treatment of nature and its resources.

Recently the President of India, the Hon Mr. V. V Giri specifically emphasized in a speech that basic education about conservation and management of wild life and forests must be included in the curricula of studies in schools. We are happy to state that the syllabus drawn up and the curricular materials prepared by the NCERT have included in them the essentials of conservation of nature. They have shown a keen awareness to the problems of conservation education and the necessity to use the natural resources in a rational way.

When the syllabus is accepted in most States we will have taken the first step towards the ultimate aim of making pupils in rural areas conservation-conscious.

Summary

The problem of introducing conservation education in schools is by no means simple. All the States in India have begun to reform the curriculum in science and it is but opportune that the need for environmental education is emphasized.

It is most effective when imparted to school children. The National Council of Educational Research and Training has achieved this objective in their new syllabi in science subjects. The syllabus in biology is ecologically based. Conservation ideas have been included and stressed at appropriate places in the biology syllabus for classes I through X/XI. An environmental approach runs through the entire biology course

In the primary stages, special efforts have been made to include topics concerned with conservation of plants, animals, soil, air and water. The middle school syllabus concludes with an important section on "Man and his environment" which is a summarized ecological perspective of the entire biology course The high school course comprises such important chapters as populations, ecosystems, biosphere and conservation of nature. The themes contain man's interactions on nature as well as a consideration of ways of maintaining the environment of the future. The normal balance on nature and the guarantee that life will exist on the earth depends on our understanding of this principle.

Appendix

Main topics of the biology course for secondary schools.

Middle School Biology

Part I (class VI)
(A) Botany. Biology of the plants.

Part II (class VII)
(B) Zoology Biology of animals.

Part III (class VIII)
(C) Human physiology Biology of man
(D) Man and his environment

High School Biology

Part IV
(E) Introduction, the basic principles of the structure and processes of life.
(F) The organism.
(G) Natural communities: Populations of species, communities and ecosystems, biosphere—balance in nature and cyling of matter, conservation of nature*

Part V
(H) The molecules and the cell.

Part VI (class XI)
(I) Fundamentals of genetics and selection
(J) Evolution

* Some details are given here for this group only

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What Geometry Shall We Teach in Middle Schools?

G.S. BADERIA AND B. BRARED

Department of Science Education, National Council of Educational Research and Training, New Delhi

EARLY development of geometry started with the study of physical objects, their shape, size, length, area of surfaces and volume of solids The study of characteristics of these physical objects gave the intuitive idea of a plane, a line and a point. Determination of the volume of a solid or a container gave the idea that volume of a solid was the measurement of space occupied by the solid. Gradually it was realised that this space would remain unaltered whether it was a solid made of wood or any other substance so long as the shape and size remained the same This space was thus an abstraction from the experience with physical objects. Since the objects exist in a physical world, in which we live, we call this space the physical space.

Euclidean geometry which has been studied in schools for 2000 years is considered to be a close mathematical model of the physical space we live in There are, therefore, two ways of studying this physical space. One is to study the properties of geometrical objects like point, line, plane, polygons, etc. through physical models by empirical methods. Another approach is to develop a strictly axiomatic study with some undefined terms, a few assumptions about these undefined terms, definitions and to prove propositions as logical conclusions of the assumed properties and other propositions already proved.

Both the approaches, namely the empirical approach and the axiomatic approach have their advantages and their weak points. The empirical approach is very suitable for lower age-groups, who are still at the stage of concrete operations in the words of Jean Piaget, and who need concrete objects to visualize geometrical relationships. However, this approach is restrictive in the sense that we are tied down to one model; the results are unsure and sometimes not even possible to obtain and also we fail to appreciate the nature of mathematics, as a study of structures. If mathematics is to be seen as a game played according to certain rules, then the consequences of one set of assumptions has to be realized.

On the other hand we have the other treatment developed strictly from an axiomatic stand-point, where point, line and plane are undefined terms or for that matter we may even have some other set of undefined terms. To these undefined terms, we assign meanings by our axiom set and prove theorems as deductions of axioms or previous theorems. By varying our axiom-set we change the structure so that by following an axiomatic approach, we may study Euclidean geometry or non-Euclidean geometry and so on

Axiomatic development of geometry is, therefore, an ideal method which can open before us the nature of mathematics However, very soon we may run into pedagogic

difficulties especially for the age-level (10^+ to 13^+) as we may find that the students for whom we are developing the course have problems of appreciating this method

We are then in a situation where one method is possible but probably undesirable and the other impossible Therefore, we feel that it may be expedient to follow the middle path—some kind of an amalgamation of the empirical with the axiomatic (deductive) approach The undefined terms that we choose are explained through examples from phsyical space and the axiom set that we want to develop is made reasonable from corresponding relationships in physical space

By now it is well-known that Euclid's treatment of geometry had some flaws in it. At some places tacit assumptions were made, e.g. cross-bar theorem, the line-circle theorem or two circle theorem were assumed without mention. In many cases if diagrams are drawn slightly differently, then impossible statements seem to be true, e.g. every triangle is isosceles or a point inside the circle is on the circle. Many of these shortcomings in the Euclid's elements can be fairly easily corrected by introducing the real number system, as is done by Birkhoff and elaborated by Moise This, however, requires the knowledge of the real number system.

Whether the continuity of the line should be tacitly assumed and whether real numbers should be naively used even though the children have not studied them are questions to which there are no satisfactory answers. We, however, have tried to steer clear of this controversy in the beginning. We have therefore considered congruence of segments and angles synthetically even before introducing measure of segments and angles.

We begin with a study of the physical space and through the handling of regular solids like cube, cuboids, sphere, cone and discs etc., we bring the idea of point, line, plane and curve intuitively Through illustrations, we develop various assumptions about incidence in a plane These assumptions are.

(1) Through any two different points in a plane, there is exactly one line.

(2) Two different lines in a plane may be:

(i) intersecting

or (ii) parallel

If they intersect, they intersect in exactly one point.

Assuming that there are sufficient number of points on a line, we next move on to discuss their relative positions. We must give some meaning to "a point lies between two other points" We will let the following figure illustrate this Here C lies between A and B.

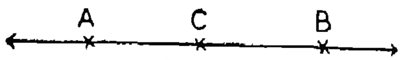

Fig. 1

A closed segment is then the union of two points on a line and all the points between

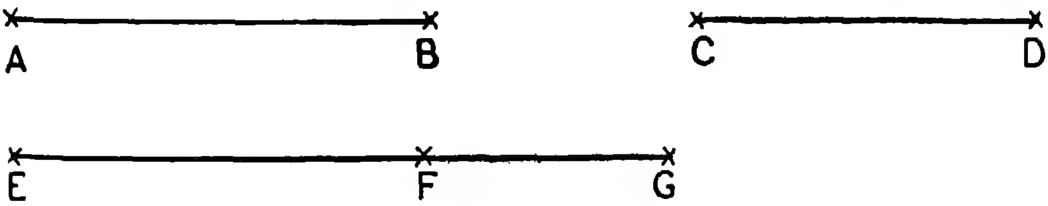

Fig. 2

these two points. The concept of open segment is also introduced here.

The concept of between-ness does not find any mention in traditional texts of geometry. However, this is a very important concept which we shall need when we discuss comparison of segments and comparison of angles, and if we want to fill the gaps in Euclid's treatment of Geometry.

We introduce the concept of congruence intuitively. For constructing the sum and difference of segments we proceed as follows:

In figure 2, if $\overline{AB} \cong \overline{EF}$ and $\overline{CD} \cong \overline{FG}$ and F is between E and G, then $\overline{EG}$ is called the sum of segment AB and segment CD.

If $\overline{AB} \cong \overline{EG}$ and $\overline{CD} \cong \overline{EF}$ and if F is between E and G, then the segment FG is called the difference of the segment AB and the segment CD (Fig. 3).

ing this approach i.e. of talking about comparison of segments and their sum and difference before talking of their measure. As we have already pointed above, we do not have real numbers available, and it is possible to postulate that every segment is associated with *a definite unique length* only by using the real numbers We have instead followed the much more natural way and associated an approximate number with a segment, the approximation depending on the instrument used, as this is what the students need in daily life and as the idea of approximation is extremely important in itself. Further-on when we compare the lengths of two objects, it is not necessary that we immediately rush to use a ruler. The books arranged in a book-rack are easily compared in the manner we propose to follow.

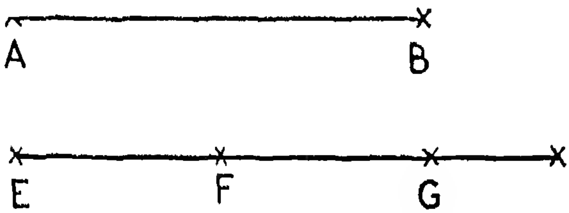

Fig. 3

Finally if, $\overline{AB} \cong \overline{CD}$ and D is between C and E, then segment AB is said to be less than segment CE or segment CE greater than segment AB (Fig 4).

Angle is introduced as union of two non-collinear rays with a common end-point. We introduce here a new term "elementary angle", the measure of such an angle being

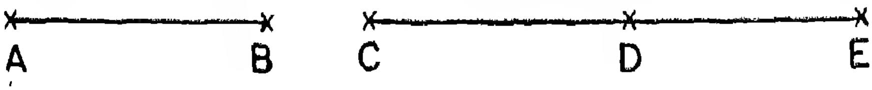

Fig. 4

Notation: seg. AB $<$ seg. CE
or seg. CE $>$ seg. AB

There may be genuine questions in the minds of many as to the purpose of follow-

between O and 180, the idea being that in the study of convex polygons we need not go beyond elementary angles. It is also sound considered from a mathematical stand-point, if we want later to assign the

status of a function to the measure of an angle. This is possible only when to a union of two rays, we assign only a unique number If we accept angles beyond 180, for the same angle we have more than one measure, e.g. in that case, in the adjoining figure, two numbers namely 60 and 300 would be assigned to the same angle.

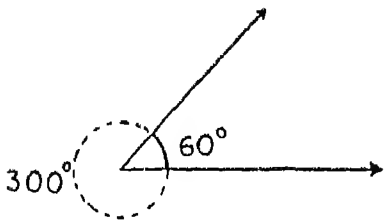

Fig. 5

We will also state that an angle separates its plane except for the points lying on the angle into two sets. the interior and the exterior. The interior is a convex set whereas the exterior is not a convex set. This characteristic can not be maintained if we accept an angle of 180° measure or greater.

Congruence of angles is discussed in the same intuitive manner as congruence of segments. For studying comparison of angles, we first define between-ness for a ray. We make a statement.

Given three rays OA, OB and OC with a common end-point O, ray OC is said to lie between the other two rays if and only if the segment PQ intersects OC where P $\in$ ray OA, Q $\in$ ray OB and P, Q $\neq$ O (Fig. 6)

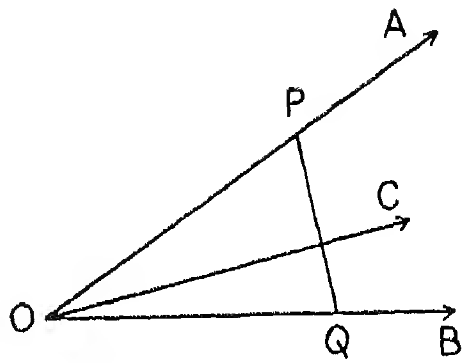

Fig. 6

For sum and difference of angles, we adopt the following approach:
If $\angle AO_1B \cong \angle POQ$ and $\angle CO_2D \cong \angle QOR$ and ray OQ is between the rays OP and OR then $\angle POR$ is called the sum of $\angle AO_1B$ and $\angle CO_2D$ (Fig. 7].
If $\angle AO_1B \cong \angle POR$ and $\angle CO_2D \cong \angle POQ$ and ray OQ is between rays OP and OR then $\angle QOR$ is called the difference between $\angle AO_1B$ and $\angle CO_2D$ (Fig. 8).

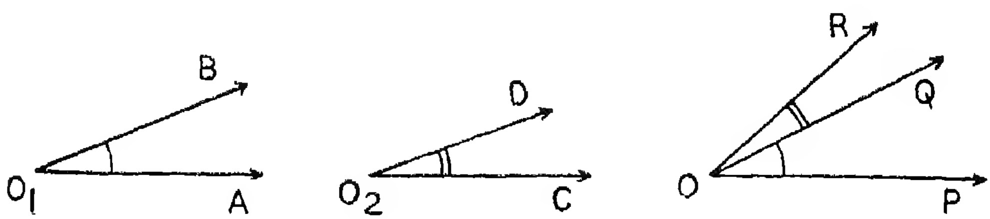

Fig. 7

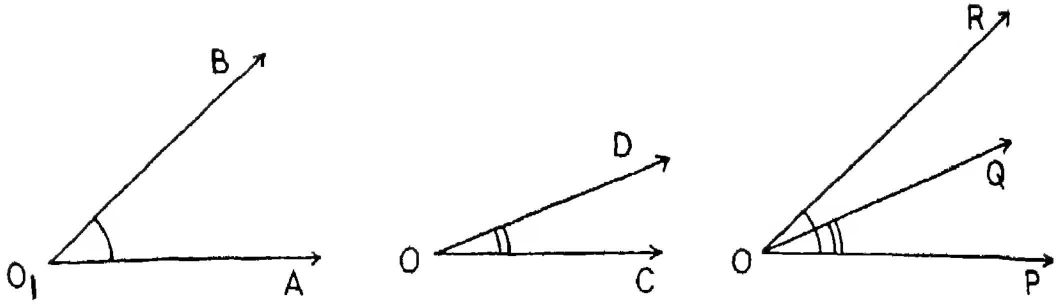

Fig. 8

If $\angle AO_1B \cong \angle POQ$ and ray OQ is between rays OP and OR, then $\angle AO_1B$ is said to be less than $\angle POR$ (and $\angle POR$ greater than $\angle PO_1Q$) (Fig. 9).

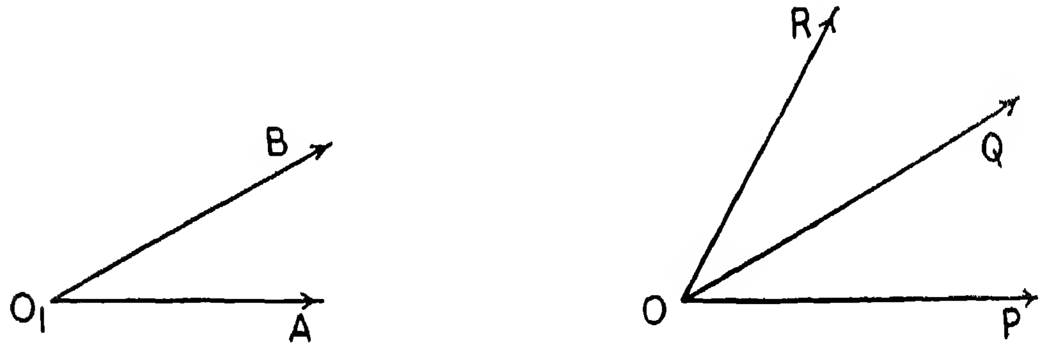

Fig. 9

After the study of angles, we pass on to parallel lines We make the parallel assumption reasonable through concrete illustrations e g. two edges of a post card, the vertical edges of a wall, etc We verify some of the properties of parallel lines. Of the corresponding angles, we give particular importance to alternate angles. After parallel lines, we pass on to triangles, kinds of triangles, angle-sum of a triangle. We establish these results empirically.

By this time, the students have acquired sufficient knowledge to pass on to constructions using ruler, set-square and compass. We take the following constructions

(i) To construct a segment congruent to a given segment.

(ii) To construct a segment equal to the sum or difference of two segments.

(iii) To construct an angle congruent to a given angle.

(iv) To construct a right angle from a point not on a given line.

(v) To construct a segment whose measure is a whole multiple of the measure of any given segment.

(vi) To construct the mid-point of a given segment

(vii) To divide a segment into three or more congruent parts.

(viii) To construct the bisector of a given angle

(ix) To construct a line, passing through a given point, outside a given line which is parallel to the given line.

Next we want to apprise students with geometric transformations. This study of geometric transformations is a recent phenomenon in schools, and the notion of transformation gives to modern teaching of geometry the central concept of function. We shall introduce students to line-reflection, a distance preserving transformation through paper folding, reflections in a mirror and geometric constructions

We arrive at the following definition of a line-reflection Given a point A and a line 1, point A′ is said to be the reflection of A in 1 if the segment AA′ intersects 1 in some point M such that AM = A′M and AA′ ⊥ 1.

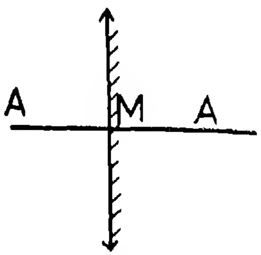

Fig. 10

We illustrate the following results·

(i) Points of one half-plane formed by the line of reflection are mapped onto points of the other half plane and vice-versa.

(ii) Points on the line of reflection are mapped onto themselves. Each such point is called a fixed point.

(iii) Reflection in a line is a 1-1 mapping of the plane onto itself.

(iv) If A′ and B′ are reflections of A and B in a line 1, then segment A′B′ is the reflection of segment AB in 1.

(v) Reflection in a line maps a ray into a ray and a line into a line.

(vi) Any line perpendicular to the line of reflection is mapped onto itself. Such a line is called a fixed line. The line of reflection is also a fixed line such that each of its points is also fixed.

(vii) Reflection in a line maps an angle onto a congruent angle.

(viii) An angle whose one side lies on the line of reflection is mapped onto a congruent adjacent angle (so that the line of reflection is the bisector of the sum of the two angles.)

Reflection in a line finds immediate applications in symmetry. An isosceles triangle has one axis of symmetry. An equilateral triangle has three whereas a scalene triangle has none.

With the help of symmetry of a circle, we can derive several of its properties.

Next we introduce a directed line and directed line-segments, and illustrate the group properties of directed segments on a line Translation on a line is illustrated with examples. The rectangular coordinate system is also introduced

Separation properties of a plane are dealt with and simple topological concepts are introduced at this stage. These include simple closed curve, region, boundary of a region and its interior and similar other concepts.

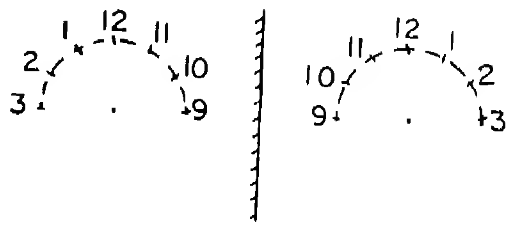

Fig. 11

Next we introduce an important property of line reflections, namely the property that orientation is not preserved under a line reflection.

Illustrations will be given e.g. a clock with its minute hand moving from 9 through 12 to 3 on a circular path. The hand will be moving clockwise but in the reflected image the same hand will appear to be moving anti-clockwise.

The concept of an oriented angle will be introduced as we see that an oriented angle AOE generated in an anti-clockwise sense will have its image as angle WOB in a clockwise sense.

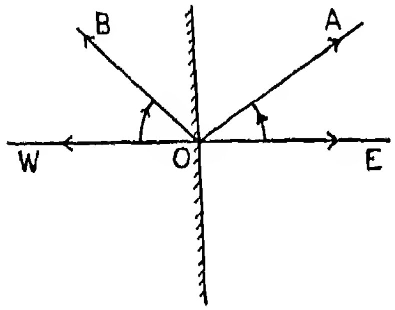

Fig. 12

Congruence of triangles is approached as a construction problem, i.e., given some data about a triangle, to examine by actual construction whether it is possible to construct a unique triangle. After giving some intuitive idea from some concrete illustrations that three independent elements are needed for constructing a triangle, we discuss different cases: SSS, SAS, ASA. These give unique triangles. ASS, however, does not give a unique triangle except when $m\angle A = 90$

The four corresponding conditions of congruence, namely SSS, SAS, ASA and RHS are stated without proof

Isosceles triangle theorem and its converse and some other theorems are referred to at this stage. This is the first occasion when students come across a deductive proof

As an application of parallel lines, we discuss properties of a parallelogram using the properties of geometric transformation, wherever possible We also discuss squares, rhombus, rectangle.

Starting with a unit square, we discuss area of different plane figures developed so far.

Following a treatment similar to "incidence in a plane" some basic assumptions relating to "incidence in space" are developed.

After talking briefly about separation, convexity and topological properties in space, we discuss prisms and introduce the concept of volume.

Circle is studied using reflection in a line and half turn. Several of its properties are developed in this manner, the main theorem being the relationship between the measure of an inscribed angle and its intercepted arc.

Once again, we come back to geometric transformations and illustrate the relationship of reflections with translation, rotation and glide reflection, i.e , we deal with the important concept of composition of functions Symmetry of parallelograms, kite, isosceles trapezium, the swastika, ring, rhombus, rectangle, square, equilateral triangle, semicircle, sector of a circle is discussed at this stage.

Finally another kind of transformation where distance is not preserved, but angles and proportion in lengths is maintained are discussed under the heading "similarity of triangles" we also prove the Pythagoras theorem here and give some simple applications.

We have chosen to deal with similarity

as we often meet the idea of similarity in daily life. In order not to over-load the student with many difficulties, we have assumed the basic proportionality theorem and its converse.

In the first year, much emphasis is laid on experimental work and constructions. For the geometric transformations also, we use paper folding and reflection in a mirror.

In the second year, we describe mainly some properties of the plane such as order properties, some topological concepts and orientation in a plane. The first obligatory deductive proof is met only in the middle of the first term of this year We also introduce calculations of areas of plane figures

During the third year, the student will meet some more abstract presentation such as composition of mappings and similarity But even here, there will be much calculation on surface areas and volumes As a whole we have tried to keep the number of theorems at a minimum.

Our effort has been that the study of geometry no longer remains study of isolated facts and learning of some skills, rather it should begin to reveal a structure with patterns which occur again and again in algebra, in geometry and in other branches of mathematics.

Graphical Solution of The Problems on Compound Interest

Miss Uma Ray
Central School, Barrackpore, West Bengal

THE computation of compound interest, as the term sounds, is sometimes very much complicated and boring This topic in arithmetic is introduced usually in a class when the children have got sufficient knowledge in simple interest. Compound interest is taught in a class in which the elementary knowledge in graph and similar figures has already been introduced.

Usually the teacher solves two or three examples before the children and then he generalises the process of finding out compound interest and establishes the formula

$$A_n = P\ (1+r/100)^n,$$

where P is the principal, r is the rate of interest per cent, n is the number of years or any other unit of time and A_n, the amount after nth unit of time.

After this with the help of above formula, inverse problems are also solved In this way, the calculation of compound interest or principal or rate of interest, becomes very much uninteresting and tedious. To break the monotony in the class and also to motivate the children towards the lessons, the teacher may sometimes pass on from numerical calculation to graphical solution, specially when it is taught before the students are familiar with the use of log-tables. By this time, they have a good knowledge in simple interest and they have also noticed that the simple interest on a certain sum varies directly as the time

CASE I: Calculation of Compound Interest or Amount after a given time on a given sum.

Example—To find the compound interest or amount after 3 years on Rs. 500 at 20%.

Construction—Let us choose a set of rectangular axes OX and OY and a suitable scale same on both the axes

Take the points P and P_1 on OX so that $OP = 100$ and $OP_1 = 500$

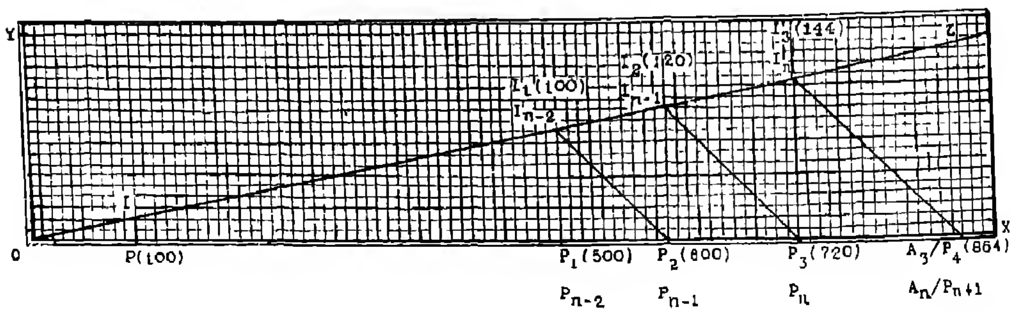

Fig. 1

Draw PI = 20, parallel to OY (see Fig. 1) Join OI and produce it to Z Draw $P_1 I_1$ perpendicular to OX, to meet OZ in I_1. Therefore, $P_1 I_1 = 100$ is the simple interest for one year on $OP_1 = 500$

Draw $\angle P_1 I_1 P_2 = 45°$ so that $I_1 P_2$ meets OX in P_2. Therefore, $P_1 P_2 = P_1 I_1 = 100$ and $OP_2 = OP_1 + P_1 P_2 = 500 + 100 = 600$. Now OP_2 represents the amount after one year or the principal for the 2nd year. At P_2 draw $P_2 I_2$ perpendicular to OX, to meet OZ in I_2. Take a point P_3 on OX so that $P_2I_2 = P_2P_3 = 120$ is the simple interest for one year on $OP_2 = 600$ and $OP_3 = OP_2 + P_2P_3 = 600 + 120 = 720$ is amount after 2nd year and the principal for the 3rd year and $P_1P_3 = P_1P_2 + P_2P_3 = 100 + 120 = 220$ is the compound interest on $OP_1 = 500$ after two years

As before, draw P_3I_3 perpendicular to OX at P_3 to meet OZ in I_3. Take a point P_4 or A_3 on OX so that $I_3P_3 = P_3A_3$ (or P_3P_4) = 144 which represents the simple interest on $OP_3 = 720$ for one year. Therefore, the required compound interest after 3 years $= P_1A_3 = P_1P_2 + P_2P_3 + P_3A_3 = 100 + 120 + 144 = 364$, and the amount after 3 years is $OA_3 = OP_1 + P_1A_3 = 500 + 364 = 864$

In this way we can find out compound interest on a certain sum for any number of years. In the case where the interest is half-yearly or quarterly, we can adjust the rate of interest and time accordingly, i.e. making the rate r/2 or r/4 and the time 2n or 4n as the case may be. Also when the number of years is a fractional one, we can adjust it in the same manner.

CASE II: Calculation of principal, when rate of interest, time and amount are given.

Example—To find the principal when time is 3 years, rate of interest 20% and amount is Rs. 864.

Construction—As before, let us choose a set of rectangular axes OX and OY and also the scale on them.

Take the points A_3 and P on OX so that $OA_3 = 864$ and OP = 100 Through P, draw PI = 20 parallel to OY. Join OI and produce it to Z (see Fig. 1).

Now, at A_3 draw $\angle OA_3 I_3 = 45°$ so that A_3I_3 meets OZ in I_3. Drop a perpendicular I_3P_3 on OX to meet it in P_3. At P_3, draw $\angle OP_3I_2 = 45°$, P_3I_2 meeting OZ at I_2 From I_2 drop a perpendicular I_2P_2 on OX to meet it in P_2. At P_2 draw $\angle OP_2I_1 = 45°$, P_2I_1 meeting OZ at I_1. Drop I_1P_2 perpendicular to OX meeting it at P_1. Therefore, from the graph $OP_1 = 500$ is our required principal. (Since the time is 3 years, we repeat the process three times.)

As a corollary, we may consider the case when, instead of amount, the compound interest = Rs. 364 is given. In that case, we, at first, find out the amount after given time, taking 100 as principal as in case I.

Proceeding as in case I, we get the compound interest on Rs 100 after 3 years as Q_1Q_4 = Rs. 72.8 (Fig. 2).

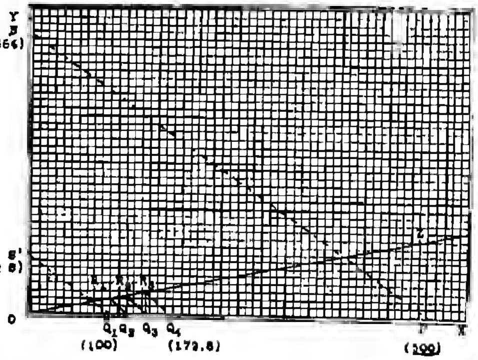

Fig 2

Now, let us take the points S' and S on OY so that $OS' = Q_1Q_4 = 72.8$ and OS = 364. Join Q_1S', through S, draw SP parallel to Q_1S' to meet OX at P From the graph, OP = 500 which is our required principal.

CASE III: Calculation of time when the rate of interest and principal (i.e. compound interest) are known.

Example—To find the time, given that the rate of interest is 20%, principal is Rs. 500 and amount is Rs. 864.

Construction—After the choice of suitable axes and scale, take the points P, P_1 and A_n (or P_{n+1}) on OX, so that OP = 100, $Op_1 = 500$ and $OA_n = (=OP_{n+1}) = 864$

Let us take PI = 20, parallel to OY (Fig. I). Join OI and produce it to Z. Draw $\angle OP_{n+1}I_n = 45°$, $P_{n+1}I_n$ meeting OZ in I_n; drop I_nP_n perpendicular to OX to meet it in P_n. Again at P_n, draw $\angle OP_nI_{n-1} = 45°$, P_nI_{n-1} on OX to meet it at P_{n-1}. Draw $\angle OP_{n-1}I_{n-2} = 45°$, $P_{n-1}I_{n-2}$ meeting OZ in P_{n-2}. In this way, we continue the process till we get the point P_1 as the foot of the perpendicular drawn from a point I_1 on OZ.

In this present case, we get $P_1 = P_{n-2}$, i.e $1 = n-2$ or $n = 3$. The number of points on OZ, rather the number of peaks being 3, the time is three years.

CASE IV: Calculation of rate of interest when time, principal and amount after given time are known.

In this case we have to face some difficulties as here we are not given the rate of interest r which is the factor determining the direction of OZ. To avoid this difficulty, we can use semi-log graphs instead of ordinary square graph Even, when we calculate the rate of interest with the help of above formula.

$$A_n = P(1+r/100)^n,$$

we have to use log-table when n = 3. (If such semi-log graph is not available, it can be prepared with the help of a slide rule, as the present writer has done.)

Example—To find the rate of interest p.c. when the principal is Rs 500 and the amount in compound interest after 3 years is Rs. 864.

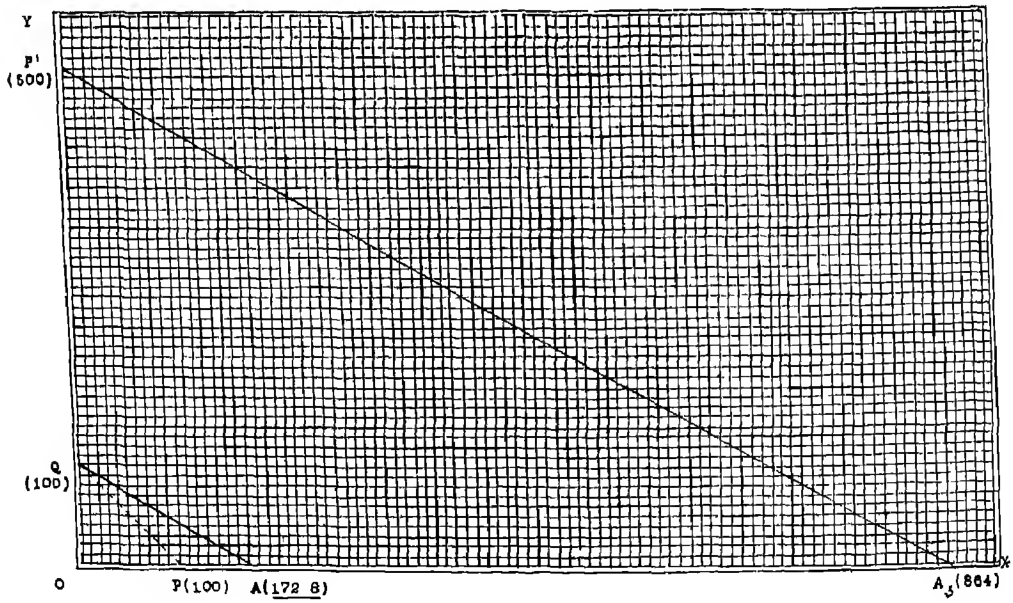

Fig. 3

Construction—At first let us take an ordinary square graph and choose a set of rectangular axes OX and OY as usual with a suitable scale on them. Take the points A_3 and P on OX and P′ and Q on OY so that $OA_3 = 864$, $OP = 100$, $OP' = 500$ and $OQ = 100$ (Fig. 3). Join $P'A_3$ and draw QA parallel to $P'A_3$ through Q meeting OX in A. From the graph, OA = 172.8. But OP = 100, therefore, PA = OA—OP = 172.8—100 = 72.8 which represents the compound interest on Rs. 100 for 3 years at certain rate.

Now, if in case, compound interest be given instead of amount, we can have PA = 72.8 after a slight modification of Fig. 3.

In the above example, let the compound interest be Rs. 364.

Construction—Take a point I_3 on OX and the points P′ and Q on OY (Fig. IV), so that $OI_3 = 364$, $OP' = 500$ and $OQ = 100$. Join $P'I_3$ and draw QA parallel to $P'I_3$ to meet OX in A. From the graph, OA = 72.8.

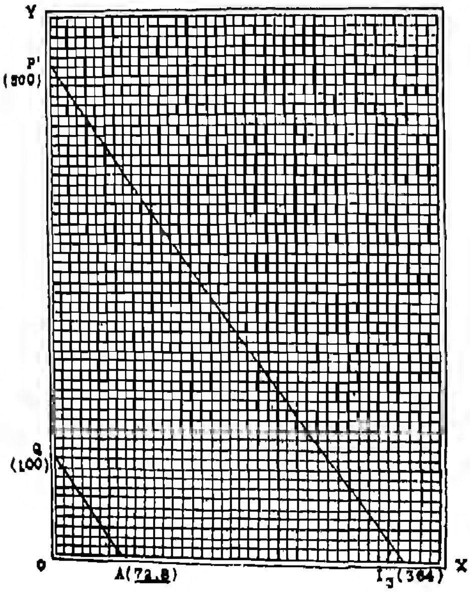

Fig. 4

After this in both the cases, we choose a set of rectangular axes OX (along Log-axis) and OY and two different scales on them, on the semi-log graph. Take R′ on OX (Fig. 5), so that OR′ = 72.8 and the points N and N′ on OY, so that ON = 3 (Time) and ON′ = 1. Join NR′. Draw N′R parallel to NR′ through N′ meeting OX in R. From the graph, OR = 20 is the required rate of interest p.c.

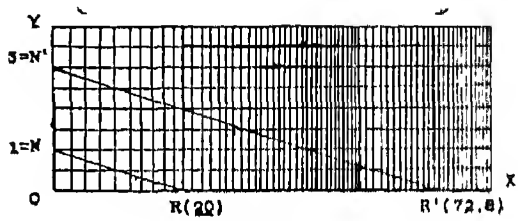

Fig. 5

Thus we have seen that any type of problem, of course on compound interest, can be solved graphically though it is difficult to get an accurate result in some areas, still this method has some advantage too. Of course when we are not getting an accurate result from the graph, we can apply the properties of similar triangles. We can get the compound interest or amount at the end of any number of units of time, i.e., the position after the 1st year or 2nd year and so on.

This method is for creating some change and variety in the classroom and to make the lesson interesting. Moreover, this will help the teacher to correlate arithmetic with geometry. In this way, any problem involving unitary method, can be represented and solved graphically.

An Ecological Approach to Biology*

Eric Caulton
Napier College of Science and Technology, Edinburgh

I do not regard the 3 approaches (human, ecological and experimental) of this symposium as mutually exclusive or in any sense competitive, but essentially complementary. For example, we ourselves as individuals, are examples of ecological experiment—living for the most part, in a society in a rapidly changing man-made environment (Lewis and Taylor, 1967) Therefore, the human approach is very important to our overall understanding of biology. That experiment is an integral part of the study of living organisms—and biology is just that—needs no further comment, and its importance in the ecological approach will be touched upon later, though I do not propose to do more than put it in its setting, as this approach is the consideration of the final contribution to this symposium

I propose to deal with the subject of this contribution by posing 3 questions and attempting to answer them in the light of past and current teaching experience and background reading

(1) What is ecology?
(2) Why teach ecology?
(3) How do we teach ecology?—implying also when and where?

What is Ecology?

Charles Elton (Elton) defined ecology as, "A new name for a very old subject It simply means scientific natural history". Just how old this subject is may be judged when one reads the writings of Aristotle on marine animals, and also those of his pupil and successor at the Athens Lyceum, Theophrastus, spanning the fourth, third and second centuries B C These two writers were seen to be keen observers of the natural scene Aristotle was both an acute and an able observer, two important ingredients in the make-up of any ecologist. Theophrastus in his "Enquiry into Plants" and in the fragment, "Concerning Weather Signs", clearly relates both plants and animals to their environment, and gives many instances of behavioural responses to environmental change.

Nearer our own time, Charles Darwin carried out extensive observations and experiments in the field with respect to earth-worms, insectivorous plants, climbing plants and numerous flowering plants, including Orchids

Some 5 years ago, Eugene Odum (Odum, 1963), the American ecologist, referred to ecology as "the study of the structure of Nature" Most recent works emphasize the interrelationship between organisms and

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environment. Ecology is thus an all-embracing concept, involving as it does the organism on the one hand at individual and population levels and the physico-chemical environment on the other. It can straight away be seen to be a subject which bristles with difficulties in its own right by its very magnitude and depth, but all the more so when it has to be taught within the confines of the early school years, with associated problems of geographical location and timetabling thrown in for good measure

Why Teach Ecology?

There are a number of answers to this question One is that children come to realise at a very early age that they share their environment with numerous other living things having much in common with themselves, e.g., movement, feeding, response to the world around them. Later they come to appreciate plants as living things too, but with fundamental differences from themselves and other animals. In our own children, a love of animals and a desire to keep them and learn about them is a national characteristic for which we are somewhat renowned. This characteristic persists into adulthood along side a developing interest with age in the growing of plants. The "pet-foods 'and gardening industries bear witness to these national passions. With this tremendous inborn advantage, it seems perfectly reasonable that our youngsters should be introduced to biology along ecological lines, building on the foundations of nature study laid in the primary school, but adding experiment and deduction to their increasing abilities of critical observation and recording

A second reason for teaching ecology lies in the growing awareness of the importance of understanding the principles involved, for the future welfare of man and the living world around him Peter Farb (1963) considers "that in the next 10 to 20 years, ecology may well become the most popular of sciences and the term 'ecology' a household word to those masses who today are ignorant of both the word and its meaning."

One likes to think also that a discipline, such as ecology (Lambert, 1964) should be taught for its own sake, because "it is good for the soul", apart from reasons such as "national characteristics" or for ultimate national/international need Even if children are approaching their biology through ecology, and have no great feeling for living organisms and what makes them "tick", but are endlessly fascinated by mechanical gadgets and have gifts in this direction, there is almost limitless scope for their talents in devising field and laboratory apparatus for mensuration, observation and experiment. It is surprising how ecology may hold their interest provided they can make their contribution in accordance with inclination and ability.

As already mentioned, ecology is based on principles which are being rapidly established, and only now becoming clearly understood and formulated. Much of what we think we understand now or may be tempted to take for granted (a dangerous approach), may have to be abandoned in the near future as investigations progress

Nevertheless, teachers of ecology have got together and suggested themes which should form the basis for programmes of work drawn up subsequently. The themes follow those principles which have emerged in the past 2 or 3 decades concerning distribution, variation, behaviour, dispersal food chains/webs, competition, etc., not as isolated topics or aspects, but as links in a circular chain (see High School Biology,

1963 Nuffield Biology, 1966-67, Dowdeswell references, 1967).

Therefore, fostering a natural interest in plants and animals, young people can be trained in accurate observation, recording, experiment and deduction, using both field and laboratory, and applying the allied disciplines of chemistry, physics and mathematics to the solution of problems, and the drawing of conclusions. In short, a thorough training is possible in the classical concept of scientific method.

Another reason for the ecological approach to biology is, that it, like the experimental approach (which of course, it embraces as an integral part), can be carried out by the children themselves at their own level. Uniquely, it can at most levels, contribute to scientific knowledge. Perhaps one of the current reasons for the present move away from science studies in our older school children, may be the feeling that they can personally contribute little to science that is original until a long period of training and successful study is concluded, and they are enabled as a result, to embark on post-graduate research It is quite possible for school children (and amateur adults for that matter) with keen observation and endowed with infinite patience, to make exciting discoveries, not only for themselves, but as contributions to knowledge, through ecological studies. The country's school and town Natural History Societies bear widespread witness to this.

How Do We Teach Ecology?

Principles of approach

How do we teach ecology in the introductory stages of a school with the ever-present restrictions of time-table and not unreasonable demands for due attentions to other subjects and the vagaries of geographical location? Problems of what to do and when to do it arise These cannot of course be considered in isolation. Ecology to be well organized must be backed by laboratory, library and museum.

Observations and recordings should of course be made in the field where problems will be posed and hypotheses formed. The solution to these problems may lie in experimental work in the laboratory under controlled conditions. It is a vital part of the whole discipline, and essential to the understanding of ecological principles mentioned earlier.

There are two ways of approaching ecology at this level, the individual organism/close-knit group of organisms, and the environment These are generally termed the autecological and synecological approaches respectively. In fact these are not mutually independent but are complementary, and are merely two aspects of the whole. Examination syllabuses from time to time, make mention under ecological sections of "well-defined habitat", or even "simple habitat". One of the first things that one comes to appreciate in ecology is that few environments may be "well-defined", and certainly none known to me may be described as "simple". Because of this fact, it is perhaps more satisfying to encourage children to study a particular species or group of animals, e.g., spiders, woodlice, beetles, within a given restricted habitat rather than to begin with the somewhat empirical environment/habitat approach that is quite commonly found (Wilson, 1965; Brady, 1965). To a youngster, a habitat will seem overwhelming in its complexity of species of animals and plants, let alone the physical and chemical factors involved. Thus from the confines of a relatively restricted autecological study, an appreciation of what constitutes the habitat may emerge

from noting the associated animals and plants, fluctuation in numbers and distribution within the habitat, ideas of competition, queries as to dispersal, and also possibly variation, although in a restricted habitat this may not be too apparent. In advocating an autecological approach to our introduction to biology through ecology, I am anxious to avoid overwhelming the pupil and possibly damping the enthusiasm which I would hope to arouse and nurture. Faced with a plethora of organisms to sort out and relate the numerous environmental factors involed to their distribution, numbers, etc., is to invite eventual boredom and frustration. Synecological studies are I think more within the province of the older student further up the school, who has gained experience in observation, recording, experimenting, through earlier investigations based on individual organisms in a given habitat.

It is here, where I think we too often go wrong. Ecology in many instances consists (or has to consist) of a visit or a very few visits to a given habitat—woodland, sea shore, pond, stream, or even a piece of waste ground—exhaustively recording the species of plants and animals present, perhaps mapping a portion or carrying out some simple quadrat or line transect analysis This work done, the pupils return home quite satisfied with the day or half-day's effort. There is value in this approach, but only in that we widen the pupils' horizons and introduce different habitats with characteristic flora and fauna. As a supporting programme, it has much to commend it, but it is not itself ecology. The one principle and all important factor to my mind that is missing is time. Hence, it is suggested that we should make our ecological approach with a particular class of children, through *regular visits*, at least once per season, over a period of 1 or 2 years. This means that our chosen habitat for autecological study should be handy, if possible accessible within the double periods of the time-table. If this is not possible, then visits will have to be less frequent perhaps seasonal, with special arrangements made for half-day visits.

In selecting a suitable organism for an autecological study the local environment will determine which may readily be found in habitats associated with the ones mentioned above for ruderals.

The studies on individual animals and plants can fall into two categories: field and laboratory. The field work might involve counting the number of plants in a given area within a given period of walking time; assessing the degree of cleanliness of leaves or the amount of infestation with insect/spider nest-webs, or the cover of leaves by powdery mildew; measuring the size of plants (overall height or sample leaf length); counting the number of flowers or capitula. Alternatively, if animals are chosen, similar approaches may be made with respect to numbers and size. Laboratory studies can be undertaken by a section of each group. Weeds might be studied individually to plot the rate of growth under varying controlled conditions; seed viability for sample batches (e.g., 100) gathered at the appropriate fruiting time; seed and fruit dispersal mechanism. On the animal side, laboratory studies can embrace the effect of light and dark; habitat preference; food requirements and feeding mechanisms; humidity tolerance. Recent compilations by the Nuffield Foundation (see reference), especially Volume 1 of Nuffield Biology (including the Teachers' Guide) provide excellent suggestions covering work both in field and laboratory.

It is essential that field and laboratory

work be correlated to emphasize the link between the two—that there is one overall problem which has been investigated both outside with observation and inside by experiment. The final report should demonstrate this dual but linked approach very clearly.

Youngsters working singly or in pairs on an autecological study in a limited habitat will as a class pooling their individual efforts, be able to contribute much to the establishment of an overall picture of the environment and thereby gain some insight into the concept of environment. This approach therefore, while basically analytical, involves synthesis Whilst much of the observing, recording and mapping will be done in the field, there will still be much to be done by way of experiment The laboratory thus becomes an extension of the field This should be the relationship in ecology. Experiment will be a necessary concomitant to establishing some of the answers to the questions posed from observation and measurement in the field Challenges to individual initiative and skill will doubtless be involved, and the gadget-minded youngster will come into his own.

From the foregoing 3-points have emerged: the selection of a limited habitat with as few variations within as to make it a workable proposition, e g , a fallen log with loosening bark, leaf litter, a patch of garden soil, a restricted portion of waste ground. Second, the site should be accessible for working in at regular intervals, and, last, with the approval of the pupils involved, the selection of certain organisms for individual study. Children do have likes and dislikes with respect to animals, and at this stage, encouragement to do what they would like to do is the more likely way to develop and sustain interest and achieve results.

This is the start Much background information will be required concerning the particular habitat, e.g., location, origin, history, geology, use by man, etc , as appropriate (Perry et al , 1968). The acquisition of such information for the background to the individual studies may appeal to some pupil or pair as their contribution, and involve visits to the site for measurement and subsequent mapping, and visits to the local reference library, where necessary Alternatively this may have to be the teacher's contribution The sessions in the laboratory should be very busy, entailing not only experimental work, but identification and searching for background information on the particular organisms selected for study. Thus the work takes on the form of a project, to which each individual or pair contributes to the whole Periodic discussion will result in the pooling of information and results, and the eventual compilation of a general picture of the environment. Each year will have its gaps, but a consistent approach over years carefully documented with maps, drawings, descriptions, photographs, etc., will result in a pretty deep and broad study of the habitat One schoolmaster following this approach, has reviewed a project in its eleventh year, when the record book was near completion (Wilson, 1968). To it each year, came the current batch of ecological recruits, searching for information to complement their own work, and in time make their own contributions.

Most ecological studies, however, will occupy a shorter, more intensive period of the overall time available. An individual class of, say, 30 pupils of varying ability presents problems when put to work on projects of this kind. One thing is certain that projects which involve personal activity and participation, are stimulating to children, in the same way that research is to

the adult investigator. The initial selection of a topic or topics to be studied, will result from visits to suitable field sites in the neighbourhood of the school Preparative discussion and background reading and reference will lead to the definition of problems to be investigated. The class will have to be divided into groups—one per project, and each group into working units, say pairs of pupils Each pair will tackle one particular aspect of the project, either in the field or in the laboratory or perhaps in each successively Suitable report sheets for recording observations, data, etc., will have to be designed by each group beforehand, and then duplicated for group use. A final summary sheet may also be required. The group leaders should be chosen if possible by the pupils themselves, who are more likely to work enthusiastically under one of their own choice He or she will co-ordinate the activities of the individual pairs of pupils involved and report progress at regular intervals to the teacher It is essential that each member of the class has an active part to play and is assigned a task suited to his or her ability. The brightest members of the class will more than likely be elected group leaders.

It is important if results are to be obtained and presented in a form suitable for use (or subsequent exhibition) that the project in each case should be limited in scope and clear cut There is always a danger that over-ambitious projects may get out of hand and result in a meaningless welter of facts and data which only serves to dampen the much-needed enthusiasm in the final stage. The teacher should emphasize the importance of making a satisfactory presentation of the results There is scope here for the practical and artistic members of the class

No reference has so far been made to one important feature of all ecological work, save for a passing reference at the outset to the Theophrastus fragment, namely the role of the weather, or as ecologists normally refer to it, climate. Where environmental studies are undertaken, whether they be geographical or biological in nature, meteorological data is essential. Sunshine, wind, rainfall, relative humidity, frost, etc., are all pertinent, and data should be available throughout the year. If the school does not keep such records, the local City or Borough Engineer's Department is usually only too happy to provide such data by private arrangement at least this has been my experience in the past. Within the habitat, finer data may be required, but at this stage, refined measurements should not be involved; apparatus should be kept reasonably simple, readily understood, and easily handled. There is always the temptation to use complicated apparatus and methods, often, one suspects for its own sake rather than any intrinsic merit. The whole question of apparatus at this level should be guided by the principle that if a simple home-made piece of equipment will do the job required as efficiently (or within the limits of required efficiency, regarded as reasonable for the level of work), then it should be made and be used by the children, rather than the expenditure of undue sums of money which can be allocated to more essential sophisticated equipment. There is, however, a time and place for the influence of Health Robinson as "patron saint" of ecology! Each situation demands individual consideration.

Method of Approach

Adequate advance preparation by both teacher and pupil is necessary. A visit to the nearest zoo can be a very valuable experience provided the visit has a pre-arranged

purpose. To view with a purpose, however limited, is to be preferred to just aimless looking This is one lesson that must be learned. The value of reading beforehand and alongside is immense The local museum can play a valuable supporting role here too.

There is need to collect and record accurately observations made on the selected species/group Care should be taken to avoid depleting the habitat, especially when it is a restricted one The bare minimum of collecting should be done, and if possible, all excess specimens should be returned to their habitat as soon as possible. Conservation consciousness cannot begin too soon The purpose of collecting is two-fold: one, to facilitate identification, and two, to make reference collections for future work—such a collection will comprise a school ecology meseum/herbarium and should be available in the laboratory for easy reference.

The need to maintain adequate and accurate records— preferably on a diary basis—should be obvious.

The devising and carrying out of experiments arising from and relevant to the study should be encouraged. Both successful and unsuccessful experiments should be recorded Negative results can often be of positive value.

Underlying all the method should be the pupils' originality; the pupils' own observations should be dominant

The use of technical terms has been deliberately avoided, particularly those in current use in ecology Our aim is not to blind children with science or to sharpen their wits on complicated terminology, which may not be understood anyway at this level. Straightforward, precise, descriptive language is always to be preferred to technical jargon, which often may be a suspect With regard to plant and animal names there is no reason why generic names should not be used, many of them are very simple anyway. The few more difficult tongue twisting ones may have novelty value. The origin of the names used is sometimes helpful as an aid to understanding, as they do have meaning

Finally, I would like to comment on two other important aspects of ecological studies, namely the role of the library and the museum.

Children are usually no stangers to books at this stage of their careers, having spent several years looking up reference books for various bits of information on topics currently studied This is often a popular homework—at least from the teachers' point of view Three types of books will be involved in any ecological study:

(a) Keys for identification of specimens;
(b) reference books for background information,
(c) laboratory guides and manuals.

The first type vary enormously in standard, according to the detail required. It should be the aim to have available a number of copies of each of the better known elementary books with keys covering the major groups of animals and plants. One calls to mind such series as the *Observer, Wayside and Woodland and The Young Specialist Looks At. . .books* One copy of each of the more advanced general keys for use by the teacher should be available—e g. Eales', *Littoral Fauna*, Mellanby's *Freshwater Biology*, Watson's *British Mossers and Liverworts, and the* various Collins Pocket Guides The school library should have for background reading such works as the excellent Collins New Naturalist and New Naturalist Monograph series These cover a very wide range of animals and plants and habitats. Children should be encouraged

all along the line to work on their own with simple keys, progressing as they feel able to more complex and critical keys. Both Nuffield and BSCS schemes (see references) have already produced excellent practical guides for ecology work in the laboratory Books like Bibby's *Simple Experiments with Animals* are most useful.

Reference has already been made to the value of museum and herbarium for ready reference in the laboratory. These should ideally be arranged on a habitat basis, not a taxonomic one. The local museum is frequently the source of expertise, apart from its exhibits, in many aspects of biology. Much depends of course on the mesuem and the funds available for staff and facilities

All this takes time over and above that available within the school hours available. Teachers are busy people and progress may therefore be slow Nevertheless, the effort must be made and sustained. The ultimate rewards are great and immensely satisfying Much depends on the individual teacher's dedicated enthusiasm.

Children very soon come to realise the destructive power that they have as human beings over their environment (Carson, 1967; Mellanby, 1967; Wilson, 1968) It is because of this, that if I were asked personally to give one reason for teaching ecology—especially to make this the approach to biology for children it is that I want children, and later adults, to care about their living environment. Albert Schweitzer's principle of reverence for life is much needed in the present day world. Only by coming into close contact with the living environment and studying it, can children come to understand it, and understanding is a prerequisite for caring - caring, not only because it is to their ultimate advantage for survival as human beings, but because it is their heritage. Children should be encouraged to think that to be conservation-minded is to be on the side of the angels or to put it in contemporary language, to be "with it."

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Study of Surfaces

Part IV—Cleaning the Surface

L. D AHUJA

Chemistry Department, Indian Institute of Technology, New Delhi

FERMI—father of the Atom Bomb once said, "Surfaces are very interesting, but there is so little of them". By this he meant that it is very difficult to get a clean surface One of the main problems associated with metal surfaces used in many of the modern industries is that metal possesses a high surface energy (500-2000 dynes/cm) and are easily subjected to contamination by the atmospheric gases. According to the kinetic theory, the rate at which gas molecules strike a surface, is given by

where $$u = \frac{P}{\sqrt{2\pi mRT}}$$

u—is rate of striking molecules per sq. cm per sec

p—is the gas pressure.

m—is the mass of a gas molecule

k—the well-known Boltzmann constant.

T—the absolute temperature.

At room temperature and atmospheric pressure, this rate works out to about 10^{23} molecular impacts per square centimetre of the surface per second. Now a typical surface possesses about 10^{15} sites per square centimetre which means that the surface gets completely covered by a monolayer in about 10^{-8} seconds One can hardly do anything in such a short interval to prevent contamination To keep a surface effectively free from absorbing gases would require a vacuum of the order of 10^{-9} mm. of Hg. On molecular scale, layers of dirt are accumulated If the chemistry of the contaminating layer is known, one can react the layer with another chemical so as to form a valatile product A more common way is to heat the surface of the solid in vacuum. The method of heating will depend on the nature of the solid substance If it is a powder, it will have to be heated in a container Most often this container is a glass vessel which cannot be heated beyond 400 to 450°C. For higher temperatures, we require silica vessels or even platinum.

One of the most effective method of cleaning the surface is to bombard it with positive ions of an inert gas. Though such a treatment leaves the surface, somewhat roughened, the damage can be repaired by annealing the surface at a temperature well below the melting point, but sufficiently high to allow surface atoms to migrate back to their normal position

A more direct, but much more difficult way to get a clean surface is to break a crystal in very high vacuum (10^{-12} mm Hg.) The main difficulty is of mounting the crystal in a vacuum chamber in such a way that it can still be operated from outside. This is usually done by driving a pair of magnetically driven wedges into the notches marked in the crystal

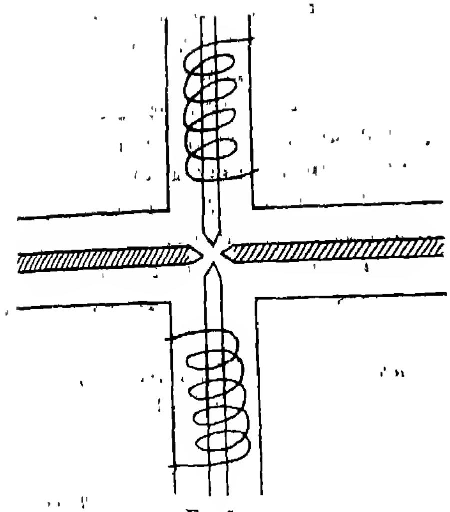


Fig 1

The above methods of cleaning are employed for surfaces which are required either for catalytic work or for the electronic devices. But for many of the systems, such high vacuums are neither practical nor needed, the term clean surface there refers to such surfaces from which ordinary contaminants like dirt, grease, etc., have been removed. For example, the surfaces required for tinning, galvanizing, painting, electroplating, etc. The purpose of cleaning here is to enable the coating material to form an alloy or solid solution with the coated material. The method of cleaning will vary according to the purpose for which the cleaned surface is required

The presence of grease, oil, dirt and other extraneous materials effect the adherence, continuity and general durability of coatings. In general, a somewhat higher order of cleanliness is required for surfaces that are to be electroplated than those that are to be painted. We now describe some of the methods employed.

Degreasing

The oily dirt present on a metal surface may be of animal or mineral origin. The former class is removed with strong alkalies while the latter by emulsification with soap or synthetic detergents. Organic solvents particularly the chlorinated hydrocarbons dissolve both classes of oils.

Degreasing with alkalies

The properties of an efficient cleaner in order of importance are

(i) dissolving power and high alkalinity
(ii) disperising power for solids
(iii) emulsifying power for liquids
(iv) rinsability.
(v) stability.
(vi) low concentration for economy
(vii) freedom from toxicity

The various alkali compounds employed are:

(a) caustic soda ($NaOH$)
(b) Soda-ash (Na_2CO_3)
(c) Sodium phosphate ($Na_3PO_4 \cdot 12H_2O$)
(d) Sodium silicate.

For reasons of economic efficiency, mixtures of varying proportions of above compounds are used.

Degreasing with soaps and detergents

Though soap is the oldest detergent known to man, in recent years, hundreds of synthetic detergents have been employed. They are mostly sulphated or sulphonated organic compounds, for example when added to alkalied, they improve the wettalibility of the surface.

Degreasing with solvents

With the development of new equipment designed to use sprays, etc., the use of organic solvents as cleaning agents has become much more popular. A solvent cleanser should possess the following properties.

(i) It should be non-inflammable.

(ii) It should be non-toxic.

(iii) It should be inert towards metals.

(iv) It should be low in specific and latent heat.

(v) It shall have low surface tension and high solvating power.

(vi) It should be volatile, etc

Halogenated hydrocarbons have been found to satisfy most of these properties as is clear from the following table.

Name	*Boiling Point* (°C)	*Vapour density* (*g/litre*)	*Surface tension* (*dynes/cm*)	*Latent heat* (*BTU/lb*)	*Specific heat* (*BTU/lb*)
Perchloroethylene (C_2Cl_4)	121	5.71	32.3	90	0.396
Trichloro-ethylene (C_2HCl_3)	87	4.53	32.0	105	0.419
Trichloro Tri Fluoro-ethane ($C_2Cl_3F_3$)	47	6.47	19.6	63	0.415
Methylene Chloride (CH_2Cl_2)	40	2.90	28.2	142	0 50

Adequate ventilation of the premesis is necessary as the toleration limit of workers for these vapours are 50-100 p.m.

In recent times, some new modifications in solvent cleaning have been tried. For example,

Cleaning by *ultra-sonic vibrations in solvents*

A high frequency sound is focussed by means of a ceramic transducer on the surface of the metal immersed in the organic solvent or detergent solution. Piezo electric materials like barium titantate or lead zirconate are used for transducers. The former are operated at 40 K.C./sec up to a bath temperature of about 50°C, while the latter at 25 K.C./sec. up to a bath temperature of about 50° C

Descaling

Scale formation is a common problem with boilers, etc. The thickness, composition and character of the scale depends upon not only on the nature of the metal, but also its past history. It also depends upon the type of impurities present in the liquid medium. The chemical composition of the scale is either a carbonate or an oxide and may be removed chemically but pickling in acids, alkalies or by immersion in fused salts. In case of steel, the usual practice is to use 5-10% H_2SO_4 at about 65-90° C, employing a cathodic inhibiter to minimise attack on the metal and hydrogen embrittlement of the steel. These inhibitors are usually organic substances like glue, sulphonated oils, thiourea, etc.

For the removal of light oxide films and carbide residues from high carbon steels, HCl of about 10% strength is used.

In the earlier part of this article, I have mentioned the use of vacuum for efficient cleaning. I think a few words about creating and measuring vacuum are called for. All of you must have seen the common laboratory suction pump made of glass, plastics or metal, whose sketch is given on next page. Such a pump is very good for quick filteration, etc. It can reduce the pressure in the vessel from atmosphere (approximately equal to 760 mm) to a few millimetres (approximately equal to 10 mm) of mercury, but is no good for a vacuum system, for which another type of pump called Rotary pump is used.

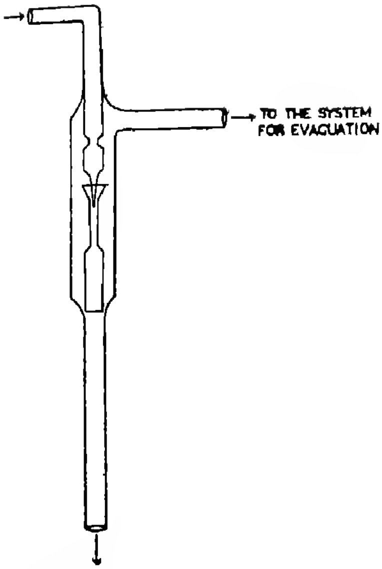


Fig. 2

Rotary Oil Pump

It consists essentially of one cylinder rotating eccentrically inside another, the two touching only alone a line of contact. A spring loaded vane divides the air pocket lying between the cylinders. There is a channel through the outer cylinder on each side of the vane. One channel is connected to the system to be evacuated, while the other is connected to the atmosphere.

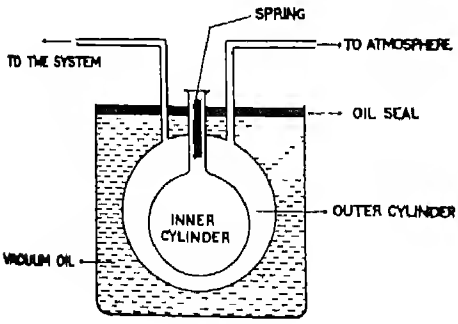


Fig. 3

The rotating cylinder draws air out of the system through one channel and ejects it out through the other. Both the cylinders are sealed in oil If properly working, it will bring the pressure in the system down to 10^{-3} mm of Hg.

In vacuum terminology, 10^{-3} mm of Hg is called a medium vacuum. In order to achieve high vacuum (approximately equal to 10^{-6} mm Hg) the rotary pump must be followed by a vapour diffusion pump.It may be either an oil diffusion pump or a mercury diffusion pump It is virtually an enclosed distillation system in which a liquid is boiled, condensed and returned to the reservoir While condensing, the vapours entrap gas molecules from the already partially evacuated system and throw them out into the atmosphere through the rotary oil pump

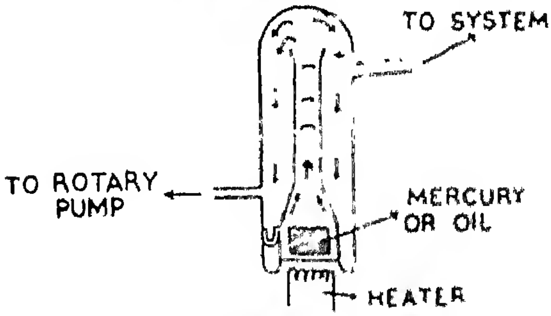


Fig. 4

Now a few words about measurement of vacuum. By far, the easiest and the cheapest way for measuring vacuum up to a tenth of a millimetre is by a glass mano-

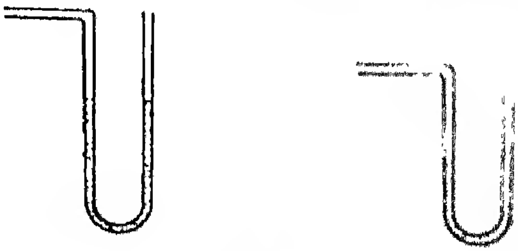


Fig. 5

metre, which is nothing but a U-shaped glass tubing, containing mercury, one side of which is connected to the system and the other side may be closed or open.

If one end is open, the height of both the limbs should be greater than 76 cm., but if one end is closed, any convenient height can be chosen.

In order to measure pressure less than a fraction of a millimetre, one makes use of what is commonly called a McLeod Gauge.

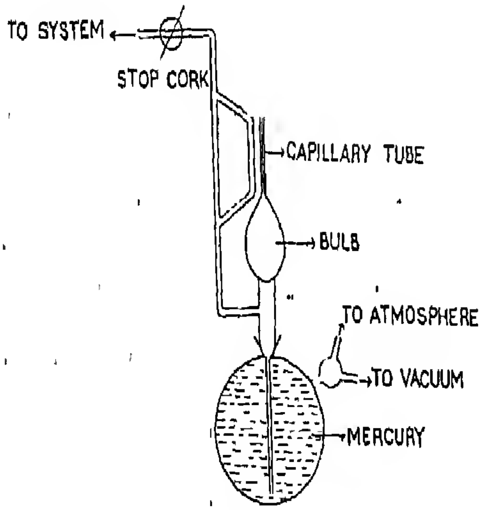


Fig. 6

Measurement of vacuum by a McLeod gauge is based upon a very simple principle. Boyle's Law for gasses

$$P_1 V_1 = P_2 V_2$$

Suppose, the volume of the bulb $A = V_1$ cc and the pressure in the system to which A is connected through $C = P_1$ mm. Hg. When we raise the mercury in the gauge, it compresses the volume V_1 to a final volume of V_2 in the capillary D. The pressure of this volume V_2 is the difference in height (h) between the top and the mark B where the mercury finally reaches

V_1 is caliberated before the apparatus is made.

V_2 is equal to πr^2 xh where r is the radius of the capillary.

$h(P_2)$ can be directly read by a cathetometre, therefore

$$P_1 = \frac{r^2 xh\, xh}{V1}$$

Many other types of gauges are in use. But the scope of the present article does not permit me to discuss all. I would only like to mention a few of them.

(a) Pirani Gauge.

(b) Phillips Ion-Gauge.

(c) Alpert Bayed Gauge etc.

The Economic Botany of Bryophytes

G. R Rao

Department of Botany, Aligarh Muslim University, Aligarh

BRYOPHYTA include the liverworts and mosses which are the simplest and most primitive members of the plant-kingdom They are of limited value to man when they are considered from a purely utilitarian or monetary point of view.

Man makes essentially no use of bryophytes as food. Peat moss is included in a "list of famine foods" published in China. However, many instances are known where they serve as a good food for animals. Moss capsules of *Bryum* and Polytrichum constitute the principal items of foods for the Alaskan Caribou and Norwegian grouse chicks

Bryophytes serve as a fuel. The peat, which is carbonised and compressed from the dead vegetation of *Sphagnum* and other mosses is used for fuel in Ireland, Scotland and Northern Europe

Bryophytes have some importance in medicine *Marchantia polymorpha* has been used in the treatment of pulmonary tuberculosis and affections of the liver. In China the decoction obtained by boiling the dried *Sphagnum* is used to cure acute haemorrhage and eye diseases. A tea made of *polytrichum commune* is purported to help dissolve stones of the kidney and gall-bladder Sphagnol a distillate of peat tar is used to the treatment of several skin diseases. *Sphagnum* has far more medical importance than other mosses mainly because of its great absorbent power and its slight antiseptic properties On account of these two properties it was used in place of cotton in surgical dressing in hospitals during the Napoleonic, Franco-Prussian and Russo-Japanese Wars. At one time a decoction of the *Polytrichum commune* was used to strengthen and beautify ladies. In U.S A moss peat is sometimes used as an absorbent in areas not having sewer systems.

Bryophytes are of much value in horticulture. Moss peat and *Sphagnum* are utilized by horticulturists and florists as media for seed germination. *Neckera menziesii, Alsia abietine, Antitricha californica* and *Hyphum tamariscinum* are used as packing materials for shipment of fruits and vegetables In Europe peat is used to pack meat, fish and eggs for cold storage.

Bryophytes are rich in chemicals. From peat, acetic acid, methyl alcohol, humic acid, carbonic acid, paraffin, naphtha have been manufactured.

Bryophytes are also used as decorative material. *Dicranum scoparium* is used by florists to form banks of green in show windows. *Rhytidiadelphus triquetrus, R Loreus* and *Hylocomium splendens* have been used as green carpets for floral exhibitions. English florists have fashioned *Climacium americanum* into wreaths and crosses

Certain bryophytes serve well as indicator plants. The abundant strands of *Marchantia*, *Funaria* and *Bryum* may indicate fires of recent occurrence. A sand stone substratum may be indicated by the presence of *Fissidens minutulus* and *F. incurvus exiguus*. The alkaline nature of a soil is indicated by *Bryum argenteum* and *Grimmia apocarpa*. The acid nature of the soil is indicated by *Dicranum scoparium*.

Bryophytes play an important part in the deposition of mineral (travertine). This mineral has been used extensively as a building stone in Italy. The deposition of this mineral has been attributed to the action of a number of mosses like *Bryum*, *Hypnum* and *Fissidens*. These plants grow in waters, containing a large amount of calcium bicarbonate. While the plants abstract carbon dioxide from bicarbonates the unsoluble calcium carbonate precipitates from water. The deposits of mineral have altered the width and height of certain Oklahoma Water falls. In Illinois and Indiana the water in numerous springs is highly impregnated with iron compounds. A moss, *Brachythecium rivulare* is common in many of these waters. As iron compounds penetrate the tissues of the moss there is formed a hard porous substance which adds to the accumulation of bog iron ore in the area near the springs

Mosses can also transform deserts and barren rocks into fertile soil. Mosses like *Grimmia*, *Polytrichum*, *Tortula* and others begin to appear as soon as sufficient amounts of soil have gathered in crevices of the rock. The moss stage is followed by the crustose and foliose lichens and precedes the herbs which in turn are followed by shrubs and trees. Bryophytes are also able to exercise their soil-binding qualities most effectively. *Polytrichum piliferum* and *P. juniperinum* are the first colonisers and stabilisers of sand in Britain. The raising of the soil level by such stabilized sand is reported to be as great as 20 centimetres This soil is more porous and rich in humus and is a favourable place for the growth of vegetation.

Bryophytes are of immense importance in Biology. In studies involving them, researchers have contributed significantly to our knowledge of various phases of plant science The first indication of the mechanism of sex determination in plants was revealed in *Sphaerocarpos*, a liverwort; Wettstein studied on regeneration in bryophytes Peat bogs afford an almost perfect trap and preserving medium for animals and plant parts By the study of pollen from peat, the character of past vegetation in the bog's vicinity may be revealed

There are many instances where man uses bryophytes for miscellaneous purposes Peat is used in paper industry and it also furnishes an excellent bedding material for horses and other animals. In old Eskimo burials moss was used as a bed upon which to lay bodies of the dead. The Eskimos of northeastern Labrador employ *Rhacomitrium lanuginosum* for lamp wicks. Peat moss have been stuffed between the timbers of houses to deaden sound. In Europe a water moss *Fontinalis antipyretica* has been used for filling spaces between chimneys and walls. Laboratory frogs are often kept in a tank with a layer of damp sphagnum, since the slight amount of iodine in the moss apparently helps prevent red-led and other infections.

Old Society With a Young Image

J. G. Crowther

In many countries the national academy of science bestows its honours on men who have already done their best work and are advanced in years. The Royal Society of London picks its Fellows young.

The author, who has published some 40 books, is a former director of the science department of the British Council and was scientific correspondent of the old "Manchester Guardian."

THE Royal Society of London is the oldest and most famous scientific society.

Though it is a private body, it performs functions similar to those of the national academies of science which in many countries are state institutions. These eminent and often ancient organisations tend to become honorific bodies, bestowing national recognition on scientists in their later years, after they have done their best work.

Early Encouragement

It is very proper that a scientist who through his discoveries has made great contributions should receive appropriate honours, but it is desirable that these should come to him at a sufficiently early age to be an encouragement to further effort. In its long history the Royal Society has given much encouragement to the outstanding younger scientists, and still does today, by electing them to its Fellowship as soon as their discoveries are seen to be of an important and solid character.

The Royal Society, like most societies, was founded by young and enterprising men of talent. The leading figure in its foundation in 1660 was John Wilkins, brother-in-law of Oliver Cromwell, and then aged 46. Other foundation members were Robert Boyle, then 33, and Christopher Wren, 28, who graduated in medicine and was an eminent scientist before he became an architect. Isaac Newton was elected in 1671 at 29. His incomparable work, "The Mathematical Principles of Natural Philosophy", was published in Latin by the Royal Society, at the personal expense of its assistant secretary, Edmond Halley, the discover of the comet named after him, who was then 31.

President for 42 Years

The dominant figure in the Royal Society during the latter 18th century was Joseph Banks, who was elected in 1766 aged 22 and became president twelve years later when he was 34. He continued as president for 42 years. At the age of 25 Banks was a naturalist on Captain Cook's first voyage round the world, in 1768-69. During their visits to Australia and New Zealand, Banks saw the possibilities of these countries, and it was mainly due to him that Britain developed them as agricultural colonies. He introduced the cultivation of the tea plant from China into Malaya—as it was then—and he inspired the famous voyage of Captain Bligh of the "Bounty", the aim of which was to introduce breadfruit trees from Tahiti for cultivation in the West Indies.

A meeting of the Royal Society of London with Isaac Newton in the Chair He was elected in 1671 at the age of 29

Banks was an outstanding representative of the progressive agricultural aristocracy that ruled Britain in the 18th century. They were superseded by the leaders of the Industrial Revolution which took place in Britain in the latter part of that century. Banks was succeeded as president of the Royal Society by Humphry Davy, who consciously set out to advance the science of industrial processes. He was elected in 1803 at 25, and became president at 41.

Davy's most widely-known achievement was the invention of the miner's safety lamp, which enabled the output of coal to be increased and the British lead in industrial development to be extended. His laboratory assistant, Michael Faraday, was elected in 1824, at 32, seven years before he discovered electromagnetic induction, and 22 years before he conceived electromagnetic vibrations, or radio waves.

Charles Darwin was elected a fellow at 29, 20 years before he published his epochal "Origin of Species".

In Their Twenties

In spite of its record, the Royal Society began to feel in the 1850's that it was not giving sufficient recognition to the younger scientists. It was partially with the aim of remedying this that Thomas Henry Huxley was elected in 1851 at 26, and John Tyndall in the following year at 31. Kelvin and Maxwell were elected at 26 and 29 and J.J. Thomson and Rutherford at 27 and 31.

Throughout the Royal Society's history, most of the British scientists who became famous were elected before they were widely known, and the tradition continues today

Among British Nobel Laureates is Professor P.A.M. Dirac who 40 years ago conceived relativistic quantum mechanics,

The Reynolds portrait of the botanist Sir Joseph Banks, who was the dominant figure of the Royal Society in the late 18th Century, being president for 42 years.

Baron Blackett of Chelsea, formerly Professor P.M.S Blackett, the present President of the Royal Society He was elected in 1965 at the age of 35

anti-matter and the anti-universe—possible states of matter which are like a mirror image of ordinary matter in terms of structure. He was elected at 27. The present president of the society, Lord Blackett, the first to photograph the disintegration of an atom, was elected at 35. The physiologist Lord Adrian was elected at 33 and Sir Peter Medawar, the leading authority on immunity on which surgical heart-transplants depend, at 34.

The brilliant band of British molecular biologists who have done so much to unravel the molecular structures on which biological heredity and other essential processes of life depend—Dr. F H C. Crick, Dr. J.C. Kendrew, Dr M F. Perutz and Professor M.H.F. Wilkins—were elected between 1954 and 1960 at ages ranging from 39 to 43.

In January 1970, the Royal Society had 37 Fellows below the age of 45 and three younger than 40 The latter are the mathematicians J F. Adams and C.T.C. Wall, and the geophysicist O.M. Phillips.

Maths Men Mature Early

Mathematicians and theorists are usually the earliest to mature. Adams and Wall are international authorities in the recondite field of topology, an abstruse development of geometry. Phillips has published particularly on the surface waves of the ocean, and the interaction between ocean waves and the atmosphere.

Among those under 45 are the eminent mathematicians M.F. Atiyah and K.F. Roth, elected respectively at 32 and 34,

both of whom have received the highest international mathematical honour, the fields Medal Atiyah, who is Savilian Professor of Geometry at Oxford, is the son of a noted Arab publicist. His contributions to topology and several other major branches of mathematics have been profound. Roth has solved problems in the theory of numbers which mathematicians had attacked for centuries, such as the approximation to irrational by rational numbers

Dr. N.A. Mitchison was elected at 38. He is a grandson of J.S. Haldane, a nephew of J.B.S. Haldane, and grand-nephew of Lord Haldane He is director of the experimental biology division of the National Institute for Medical Research in London, where he investigates immunity in animals other than the human and pursues research which has a fundamental bearing on the problem of cancer

A.R. Battersby, who was recently appointed to a chair of organic chemistry in the famous Department of Chemistry at Cambridge directed by Lord Todd, was elected to the Society when he was 41. He has published much on the chemistry of natural products, especially on alkaloids important in medicine.

Science and a Poet

Desmond King-Hele was elected at 38 After the launching of the first artificial satellites he took the lead in the determination of the properties of the upper atmosphere, and the earth's gravitational field, from an exact analysis of their motions. He combines international eminence as a theoretical astronomer with notable contributions to literature His book "Shelley, His Thought and Work" contains a unique study of the influence of scientific ideas on Shelley's poetry.

One could make more than one list of the younger Fellows parallel to that which has been made here, but this will suffice to show that the Royal Society has generally encouraged gifted scientists by electing them at a comparatively early age, and that it continues in the tradition with which it started three centuries ago.

The society also provides more than a score of senior research fellowships, mostly held by abler younger scientists who subsequently become candidates for fellowship. It awards annually about 200 bursaries of various kinds to British and foreign scientists. Finally, it gives grants to nearly a score of schools to help research projects, so there is even a direct connection between the society and research-minded school boys.

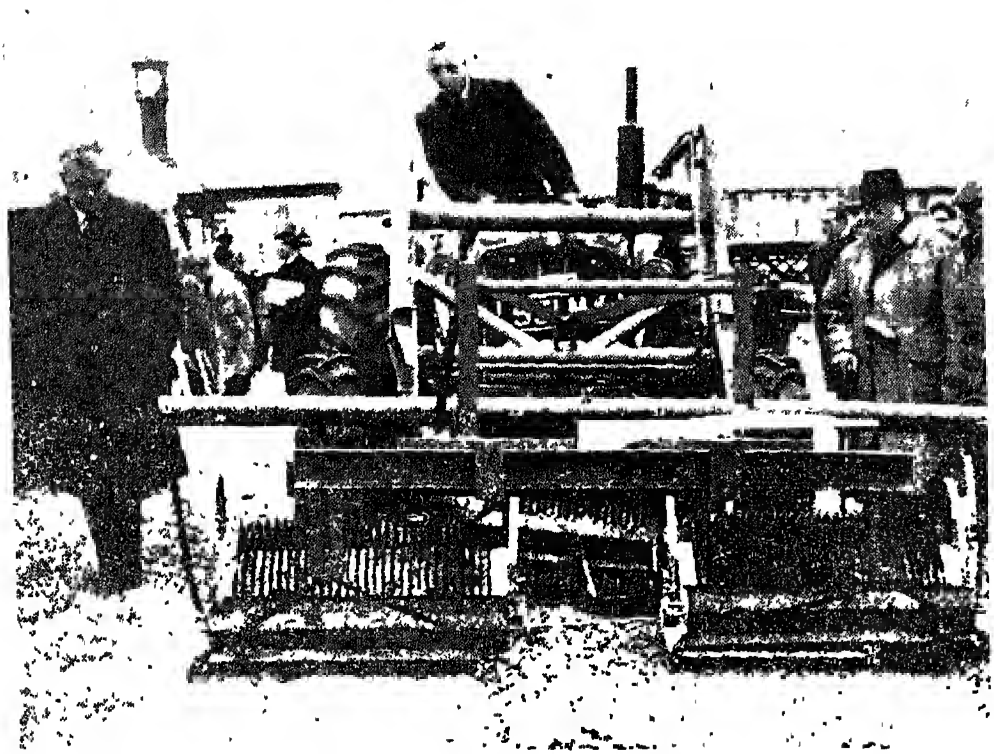
By Courtesy:
British Information Service

Oil in the Wrong Place

J. Wardley Smith

Every year, all over the world, more and more people are going down to the sea for pleasure Some go to boat, some to fish, some to swim and some just to sit on the beach in the sun. All of them will at some time meet oil pollution Small boats get a dirty line of oil around the water line, people swimming come out of the sea with blobs of oil on their bodies; people sitting on the beach find when they get up that they have black lumps of tar sticking to their clothing or to themselves These things occur in a "normal" summer but sometimes things are much worse. Whole areas of beach are covered with a wide band of evil smelling brown or black oil Dead birds are washed up, detritus becomes coated with oil and the beach for the time being becomes almost unusable. The cost to the owners of the foreshore—mainly the local authorities, the boat owners and the holidaymakers themselves—of cleaning up the oil and repairing the resultant damage is large. This is not a local problem but one met on almost every ocean shore in the world. It is at its worst close to the main sea-routes, close to oil-terminals and to the major ports, but it is nevertheless a world-wide menace. Ordinary people everywhere ask "What is being done to remove this oil pollution? Someone can do something. What is the Government doing?" This article explains what has been done in the United Kingdom to help to combat the problem of oil pollution. It also describes the measures taken by the major oil companies throughout the world to reduce the hazards.

Every small boat with its outboard motor taking a fishing party along the coast is polluting the sea by oil Tiny quantities of oil are ejected into the exhaust and round the bearing of the propeller. This sort of oil pollution does no harm to anyone or anything. Larger ships going about their business produce rather more oil and the pumping of bilges may, on occasion, produce a fairly large localised oil slick, but, as we will discuss later, this has been mostly eliminated by international legislation However, tankers, which are usually large and specially designed to carry crude oil and oil products, fuel oil, petrol, etc., from oil wells to refineries and from refineries to user countries, present a problem. When they have emptied their cargo these vessles are very light and would float high out of the water. To make them stable and sea-worthy many of their tanks have to be filled with water ballast. This must be pumped out when the ship arrives at its destination for refilling. To save time at the port of loading it is customary to clean the tanks at sea and refill them with pure, clean sea-water which can be pumped over the side in the port without producing local pollution This cleaning process means that, at some stage, a mass of oily, dirty water has to be diposed of. Up to a few years ago this was discharged into the sea



Machine designed by Warren Spring Laboratory for removing lumps of "tar" from beaches.

In 1954 an international agreement was drawn up, largely at the instigation of the UK, which prohibited oil tankers from discharging their oil within 100 miles of land. Since then many nations of the world have signed the agreement. Nevertheless, oil is still discharged in this way and can be blown by the wind over great distances to land on beaches. Not all tanker operators obey the rules. Still more recently the major oil companies have evolved a "clean seas policy" which has reduced the amount of oil pumped over the side in the cleaning process to only a few per cent of what it was before. The international regulations themselves are now in the process of being tightened up, so that even the small amount of oil discharge which had previously been permitted is now reduced to such an extent that, if the regulations are obeyed, it will not produce a permanent film and so cause pollution problems.

Pollution can still arise from ships which break the law and from ships which have had an accident. Major accidents occur when one ship runs into another, or runs aground or hits a rock, or, what is more likely, when one of the operations on board ship is carried out incorrectly and causes some oil or oily water to be pumped over the side. Occasionally, this spillage happens because of the failure of some pipe or mechanical device, but in general it is due to human error But the increased automation of oil tanker operations, the use of larger ships, and the pressure which

is being put on both masters and crew to keep the seas clean, are all producing results, and there is no doubt that the seas are, in general, becoming cleaner

The known and visible effects of oil pollution are seen in the mess it makes on the beach and on small boats, and the fact that it proves fatal to some seabirds, mostly the diving birds. Fortunately, a large oil spill, objectionable though it is, has little long-term effect on the flora and fauna that live in or near the sea When first spilt, the oil floats on the water and there it does not affect fish, as these will swim away from water that they do not like. Oil washed onto seaweeds, shelfish and the inhabitants of rock pools has little effect, provided the oil contamination is not repeated day after day, week after week. A single heavy dousing with oil appears to have little permanent consequences.

Since men started using oil on a large scale, many millions of tons have been spilt upon the seas of the world, yet in general terms, one seldom sees even a thin film of oil on the surface of the sea. The life of floating oil is comparatively short. It evaporates, it changes its character under the action of the light and oxygen of the air and it is destroyed by the innumerable specialised microbes living in the sea.

Nevertheless, accidents do happen and any oil discharged on the sea has to be dealt with. It would seem that oil is much easier

Spraying a contaminated beach with detergent

to deal with while it is floating on the sea, rather than after it has been mixed with sand and rocks on the sea shore. At first sight there seem to be several ways in which floating oil could be dealt with. It might be burnt, for after all, crude oils are known to be highly inflammable. It might perhaps be skimmed off the surface using some sort of giant scoops; alternatively it might be absorbed, like ink is absorbed by blotting paper and then the oil absorbent material could be removed, or, some sort of emulsifier or dispersant could be used so that the oil would be broken up into an emulsion which would be dispersed into the sea. Lastly, as a simple experiment will show, a heavy powder such as sand could be sprinkled onto the floating oil to which it sticks and which finally sinks it to the bottom. All of these methods, when tried on a small scale in a bucket or the bath, are quite effective, but unfortunately the position is rather different on the open sea.

A large oil spill may produce a thick layer on the sea, although it will usually spread out very thinly over the surface. At the time of the *Torrey Canyon* disaster, which was one of the largest accidental spillages of all time, it was estimated that some 20,000 tons of oil was spread over about 40 square miles of sea. This means that if the oil film were uniform it would be about one hundredth part of an inch thick. Oil as thin as this clearly cannot be burnt nor can it be sucked or scooped off the surface mechanically. If burning is to be adopted, then the oil will have to be burnt very close to the ship where it is still fresh and in a fairly thick layer. In these circumstances it is likely that the ship would be burnt as well as the oil, so that only in very exceptional circumstances is burning feasible. Similarly, mechanical removal on the open sea appears to be, if not impossible, very difficult and so far no successful equipment has been designed.

A foamed plastic such as polyurethane or polypropylene foam, will be found to absorb oil very readily and water much less readily. This suggests that this sort of material, broken into small pieces, could be distributed over the floating oil and then the whole mass could be scooped up and taken away. To spread light chips of foam uniformly over a few square miles of oil floating on the sea is, however, not an easy process. Furthermore, the collection of large amounts of floating, oily foam is difficult and tedious even if the sea is calm. The only time a method of this sort has been used on a large scale, some 30,000 tons of absorbing material and oil had to be removed from the nearby rocky shore!

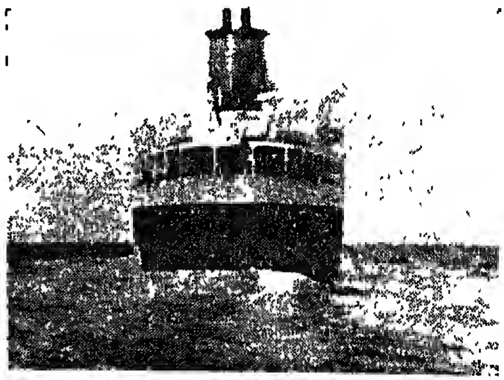
Every housewife knows from washing her greasy plates, that water with a little of a

Determination of oil remaining in a sample of treated shingle

modern detergent will remove oil from solid surfaces and keep it in suspension so that it can be poured away. This is the basis of what is, at present, the most satisfactory way of dealing with floating oil. The oil must be sprayed with a suitable chemical or detergent so that it can be agitated or shaken up with the water to break up the oil into little drops. These little drops, if kept in motion by the wind and waves, will not join together to make a continuous oil film, so that the oil remains unobjectionable until it has been acted upon by the natural agents which we discussed above. This is a *double operation*, *firstly*, the *chemical* has to be sprayed on the floating oil and secondly, the treated oil must be mixed with the top layer of the sea. Sometimes the waves themselves are adequate to beat the oil into fine droplets or even into an emulsion. On the other hand, the mixing can well be done by spraying the treated oil with powerful water jets or by using the propellers of small boats to stir up the surface. If this is possible then the oil is made relatively harmless to man and marine life. Unfortunately, the first materials which were developed to carry out this task satisfactorily were themselves by no means harmless to things that lived in the sea. Nevertheless, the damage that even these relatively toxic materials can cause when sprayed on oil floating on the open sea is very slight as there is a big volume of water even in a shallow sea. Although a great deal of toxic chemical might be used it is still only a very small fraction of the volume of water beneath it. At the time of the *Torrey Canyon* disaster, a very large quantity of a fairly toxic material was sprayed on the sea around the Cornish coast, but a careful investigation showed that there was no permanent damage to any fish caught for food. In fact, by one of those curious statistical surprises, more fish were landed during the year in which the *Torry Canyon* incident occurred than in the year before or the year after.

This satisfactory way of dealing with floating oil was developed in Britain in 1960-61 and it has been used on a worldwide scale on every major oil spill until recently. While the original detergents were toxic to marine life, in the last year or so a number of materials have been discovered which are good emulsifiers and are much less toxic.

Two of the more recent ones are the ICI material Dispersol OS and the British Petroleum material BP 1100. Both of these materials are a thousand times less toxic than the materials previously used. Dispersol OS appears to be suitable only for use with the oil floating on the sea but BP 1100 can be used both for this purpose and also to emulsify the oil after it has landed on the beach. Undoubtedly, we shall see other less toxic materials developed and their use will be widespread.



Large scale experiments on oil slicks produced by tankers being carried out at sea by scientists from the Warren Spring Laboratory.

The final method mentioned was to sink the oil. A satisfactory way of getting rid of

the oil once and for all would seem to be by putting it on the bottom out of sight. Unhappily this may not be quite true. Many sorts of fish and plants live on the bottom of the sea, particularly in the shallow seas which surround most continents. Before one can sink a large quantity of oil, one must find out what the effect will be on life at the bottom. How long will the oil remain oily? Some fishing is carried out by nets being dragged across the sea bed to catch the fish which are living there. In fishing areas such as the North Sea, all fishing grounds are estimated to be fished over at least once a week. If the sunken oil was in such a state that it would harm the fish, or soil the net, or contaminate the catch, this would be most undesirable. Work is going on to find out how long the sunken oil remains on the bottom before it loses its oilness, and whether, as is suspected, the particles of oil and sand are drifted along by the current. If such were the case the oil might land on a beach or on some remote fishing ground, so that before this potentially useful method can be used a lot more information is needed

The finer the powder which can be sprinkled onto the floating oil, the better it holds the oil to the bottom. This immediately raises the problem of how to spread a fine powder over a lage area of oil. One way is to blow it out of a pipe and let the wind do the rest. This is satisfactory provided the wind is in the right direction and there is only one boat about. When there is a large oil slick and attempts are made to treat it with a number of boats, then inevitably some boats get into the cloud of fine powder. This is unpleasant and dangerous and can damage the navigational and other equipment on board. Thus the problem of distributing a fine powder is by no means easy. Fertilizers in powder form are, of course, distributed over land, but for ease of spreading by distributor or aircraft they are granules which would be too big for oil sinking. However, instead of a powder, sand can be used, perhaps treated to make it stick to the oil. If this treated sand can be put on wet with a lot of water, in the form of a sand and water slurry, then the problem of distribution is much easier.

All round the coasts of the world, large dredgers are used to suck sand from the bottom and remove it from entrances to harbours and shipping channels Hence, wherever an oil spill is likely to occur there is also likely to be a dredger and a supply of sand. If the difficulties mentioned above can be overcome cheaply, it would be possible to equip large dredgers and have them ready so that if there is a major catastrophe they could go out at short notice and sink the oil.

Oil arrives on a beach mostly in three forms: as a thin liquid, as a heavy sticky glutinous mass, or as lumps almost like rubber, which under the influence of the sun soften into "tar". The last of these, which comes sporadically, is hidden in the shingle and is brought to the top by a high tide. It is most difficult to clean up mechanically, unluckily, and the only really satisfactory way is to pick up the odd lumps by hand during the ordinary process of cleaning the pleasure beach. The other two sorts of deposited oil are more usually the results of an accident, the lighter material being usually derived from a crude while the heavy one in all probability comes from a fuel oil. These must be mechanically removed, as far as possible, by the top surface of the oiled sand or shingle being scraped away by machines and dumped inland where the oil will not prove harmful. Then the still dirty beach can be cleaned by spraying it with one of the available detergents mentioned

above and washing down either by the sea at the next high tide, or, if that takes too long by hosing it down with fire hoses from the local water main It is possible to estimate in the laboratory how much oil remains in a sample of shingle removed from a beach after treatment with detergent. This is an effective method of dealing with an oil spill. If a large spill is being tackled then the cleaning costs more and goes on longer, but it is equally effective however large or small the accumulation of oil on the beach.

The U.K. has played an important part in all of these discussions, tests, trials and inventions for preventing the emission of oil and also for cleaning up after a spill. The work carried out by the Ministry of Technology in the early sixties was the first systematic examination of the problem in all of its aspects Recommendations were made to all the local authorities around the coasts of the British Isles so that they would know how to deal with oil should it arrive. When the *Torrey Canyon* disaster occurred off the Cornish coast, it found the authorities and the Government prepared to deal with the emergency, and, as a result, the beaches of Cornwall were cleaned before the start of the holiday season. Nevertheless, research and development have continued and many of the advances discussed above are the result of work of British industrial concerns and of Government Departments, such as the Ministry of Technology and the Department of Agriculture, Fisheries and Food. To deal with the oil after it has been spilt is one thing; the right thing to do is to stop it being spilt in the first place. In the international discussions on the control of the discharge of oil, the U.K. has taken a leading part. The original discussions which led to the setting up of the Intergovernment Maritime Co-operative Organisation were sponsored by the U.K. and the first International Convention on pollution of the seas by oil was largely a British document. The U.K. too has carried out experiments and tests which have led to the amendment of this document so that the danger of the international discharge of oil is still further reduced. These investigations are continuing.

Classroom experiments

Classroom Experiments on Acceleration

ASOK SINHA AND BINA GHOSH
Saha Institute of Nuclear Physics, Calcutta

IN an earlier report we discussed how acceleration could be demonstrated in a classroom with a three-wheeled trolley fitted with a pendulum. Here we shall discuss how the same trolley with the pendulum can be used to establish a relation between the force applied, mass of the body and the acceleration produced in it.

To find a relation between the force and the acceleration, the trolley with the hanging pendulum is placed at one end of the long glass plate. The trolley has three wheels and is provided with a stand as shown in Fig. 1. The stand bends perpendicularly

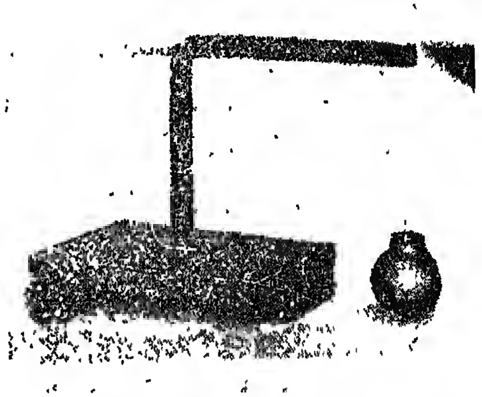


Fig 1

No. of Observation	*Force*	*No of Cycles*	*Distance within each Cycle in cm*	*Velocity in cm/sec*
I	Weight of the pan=30 gm	1	7.8	14.18
		2	14.5	26.61
		3	20.0	36.36
		4	27.0	49.09
II.	Weight of the pan+5 gm=35 gm	1	8.3	15.1
		2	16.0	29.09
		3	24.0	43.63
		4	30.7	55.81
III.	Weight of the pan+10 gm=40 gm	1	9.7	17.64
		2	20.0	36.36
		3	27.5	49.99
		4	37.0	67.27
IV	Weight of the pan+15 gm=45 gm	1	10.2	18.55
		2	21.5	39.08
		3	32.0	58.17
		4	42.0	76.35

at a height of 8 cm from the fixed point. From the free end of the stand, a heavy but hollow pendulum is suspended. A brush soaked in ink is attached to the lowest end of the bob which when in contact with the glass plate makes impressions on it The time period of the pendulum is determined and the weights are placed on the pan. The weight of the pan plus the weights placed on it are the applied force The trolley is allowed to go while the bob swings The trolley moves under the influence of the force and the pendulum traces a track on the glass plate. The experiment is repeated with three other weights on the pan and each time a different track is obtained. Tracks obtained for four different observations are shown in Fig 2.

Time-period of the pendulum = 0.55 sec
Mass of the trolley = 900 gm

The time-velocity graph drawn for each set of observations is shown in Fig. 3. The acceleration with which the trolley moves can be calculated from the graph. Each graph shows that the trolley moves with uniform acceleration in each case and the acceleration of the trolley increases with the increase in the magnitude of the force acting on the trolley.

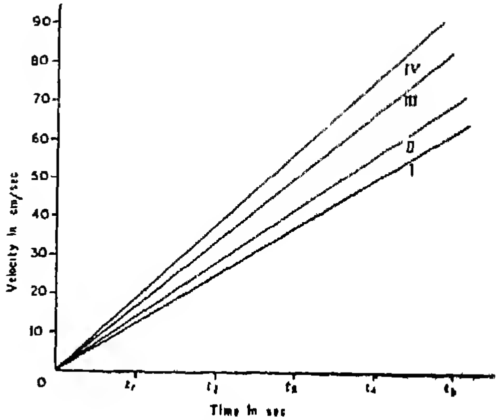


Fig. 3

Relation between mass and acceleration can also be demonstrated in a classroom. The trolley is placed on the glass plate and a weight of 5 gm is placed on the pan. This weight is the force acting on the trolley and is kept constant throughout the experiment. The mass of the trolley is changed by placing slotted weights on the trolley. The experiment is first done without placing any weight on the trolley Then the experiment is repeated for three other weights, 0.5

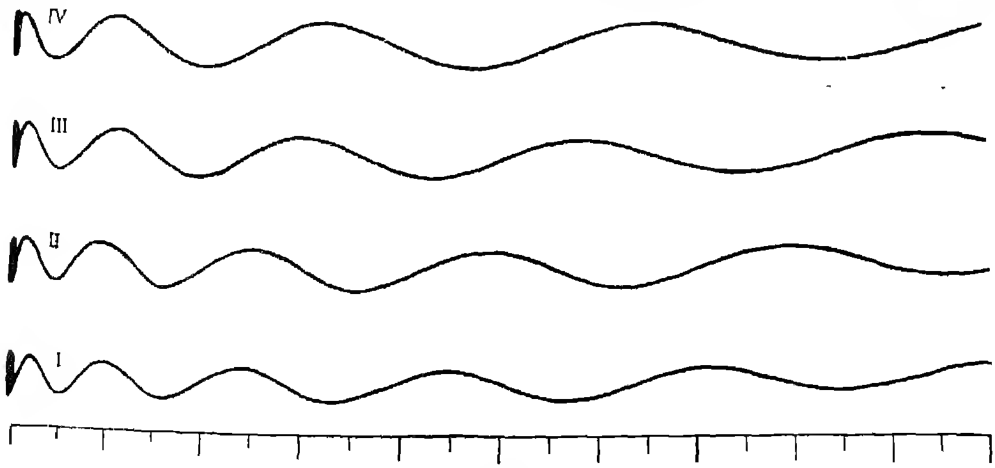


Fig. 2

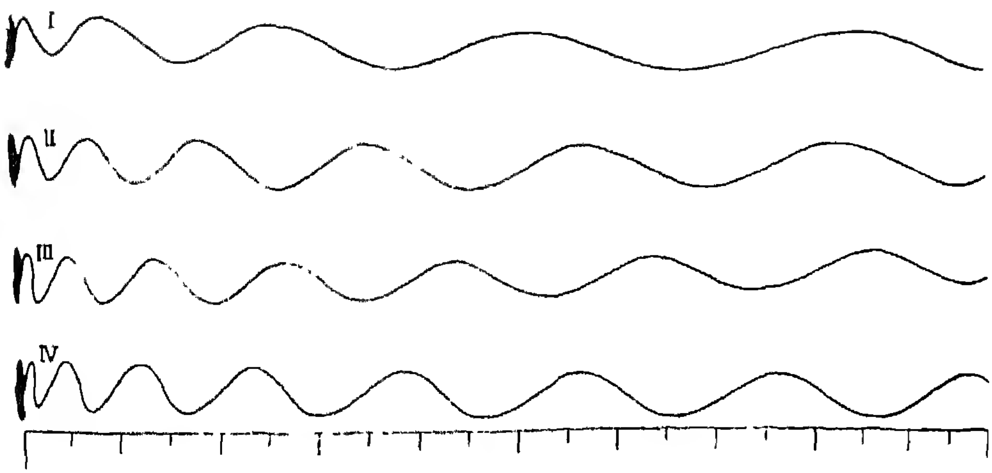


Fig. 4

kg, 1.0 kg and 1.5 kg. Tracks obtained in each case are shown in Fig. 4.

Total weight of the pan = 30+5 = 35 gm
Time-period of the pendulum = 0.55 sec
Mass of the trolley = 900 gm

The time-velocity graph is drawn for each set of observations as shown in Fig. 5 It is seen from the graph that the trolley moves with uniform acceleration in each case but the acceleration decreases with the increase in the mass of the trolley.

No. of Observation	Mass	No. of Cycles	Distance within each Cycle in cm	Velocity in cm/sec.
I.	Mass of the trolley = 900 gm	1	8 5	15.45
		2	17.5	31.81
		3	25.7	46 72
		4	33.5	60.89
II.	Mass of the trolley + 500 gm = 1400 gm	1	5.6	10 5
		2	11.2	20 36
		3	16.7	30 36
		4	21.6	39.27
III.	Mass of the trolley + 1000 gm = 1900 gm	1	5.5	10.0
		2	10.8	19.63
		3	14.9	27.09
		4	18.2	33.81
IV	Mass of the trolley + 1500 gm = 2400 gm	1	4.7	8.54
		2	9 0	16 36
		3	13.2	24 0
		4	16 4	29 82
		5	18 5	35 63

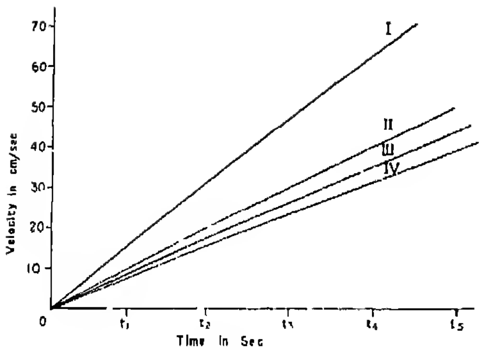


Fig 5

The major source of error in the measurement of acceleration is friction. The possible frictional error may be due to : (1) friction between the wheels of the trolley and the glass-plate (2) friction in the ball bearing arrangement (3) friction between the brush of the pendulum bob and the glass-plate We shall find out a mathematical explanation of the whole treatment, correct it for friction and compare the results with those obtained experimentally.

The arrangement is shown in Fig 6 where M_1 represents the mass of the trolley and M_2 the mass of the weight of the hanger or the pan plus the weights placed on it The weight of all these are the applied force here. The two masses are connected by a very light string passing over a smooth pulley. The trolley rests on the table and moves in the horizontal direction with an acceleration a_1 under the force T, the tension of the string. The weight of the trolley is balanced by the reaction of the table and therefore, the only force that causes acceleration in the trolley is the tension of the string T.

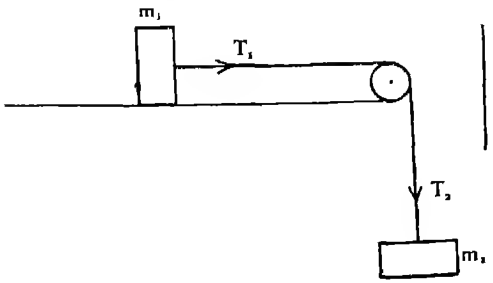


Fig. 6

$$\therefore T = M_1 a_1$$

If friction is not negligible then

$$T—F = M_1 a_1$$ where F is the frictional force which acts against the direction of T.

Let a_2 be the acceleration of the mass m_2 which hangs vertically Forces acting on m_2 are its weight m_2g acting vertically downwards and the tension T of the string in the vertically upward direction.

$$\therefore m_2g—T = m_2a_2$$

If the length of the string is constant, then the displacements and therefore the accelerations of the two masses are same. Let their acceleration be a.

Then $a = a_1 = a_2$

Now, $T—F = m_1 a$

and $m_2g—T = m_2 a$

$$\therefore a = \frac{m_2g—F}{m_1 + m_2}$$

From this relation we can calculate the value of acceleration and compare this value with that obtained experimentally. Now to measure F, the pan is removed and weights are tied to the free end of the string. The total weight attached to the end of the spring when the trolley just moves is F, the force due to friction.

From the experimental observations shown in the above two tables, the values of accelerations are calulated for each set and then compared with theoretical value.

No of obs.	m_1 in gm	m_2 in gm	f in gm	Acceleration in cm/sec² Experimental value	Theoretical Value
1.	900	30		20.43	21.07
2.	900	35		25 16	26.20
3.	900	40		28.83	31 27
4	900	45	10	34 98	36.29
5.	900	35		27.49	26 20
6.	1400	35		18.16	10.07
7	1900	35		14.29	12.66
8.	2400	35		11.9	10 06

Experimental results as shown above agree with the theoretical values. The possible errors may be due to the rocking effect of the heavy pendulum bob on the trolley.

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New Desalination Process

AUSTRALIAN scientists are looking for more efficient, cheaper ways of desalting water. The Water Purification Section of the C.S.I.R.O. Division of Applied Chemistry, led by Dr. D.E. Weiss, is studying some novel techniques which parallel the low energy methods used by nature to regulate salt in plant and animal tissues.

In giving an account of desalination research in the Section on the Australian Broadcasting Commission's radio science programme 'Insight' recently, Dr Weiss agreed that although the new techniques have not yet reached the stage of practical application, the researchers are "cautiously optimistic" that they are on the right track.

Designers of the new generation of desalination processes are taking leads from biological processes and are turning from the sledge hammer approaches represented, for example, by distillation based on vast nuclear power sources, to more subtle and sophisticated concepts.

The most promising method under development is a process for cheapening a long established but prohibitively expensive ion exchange technique used mainly for producing ultra pure water for steam boilers.

The principle of ion exchange is attractive because, like nature and unlike many desalination systems devised by man, it removes salt from water rather than water from salt. The salt is absorbed from the saline water by a bed of resin beads each about one-tenth of an inch in diameter.

Although the raw material is relatively cheap, the salt must periodically be removed from the resin beads, and requires quite 'large amounts of chemical energy' with the result that the total process is too expensive for most practical applications.

In collaboration with the Australian Mineral Laboratories and local Australian industry, Dr. Weiss and his colleagues have developed some new polymer resins which do not require chemical energy for their rejuvenation; salt is removed by raising their temperature. After the new style resins have absorbed salt from cold brackish water, the salt is removed and the resins rejuvenated by simply washing them with hot water. These so-called 'Sirotherm' resins stretch when heated and contract when cooled.

The efficiency of such an ion exchange process depends upon the area of the resin surface in contact with the saline water. Thus for a given weight of resin, the finer the particles the greater the efficiency. However, physical separation difficulties place a lower limit on the firmness of the individual resin particles.

The Australian water purification researchers, however, have made a discovery which could allow much finer particles to be used and so still further increase the efficiency of the ion exchange process. They found that by incorporating extremely small magnetic particles within the tiny resin

granules, their flocculation and deflocculation, could readily be controlled. Under experimental conditions, particles as small as bacteria have been handled successfully.

Dr. Weiss said that although much research and development has yet to be done before alternative processes can replace nuclear powered methods for major water desalination plants, he believes that they will ultimately do so. He explained the need for large surface areas in desalination systems and compared the 10,000 miles of 1-inch tubing required for heat transfer in a sea water distillation plant of 100,000,000 gallons per day capacity, with the minute tubes of the membranes used in the reverse osmosis process; miles of such tubing, no thicker than a human hair, can be fitted into a very small space.

Australia's New Telescope

The 150-inch telescope now being built at Siding Spring in New South Wales, Australia, will be by far the largest optical telescope in the southern hemisphere. The joint Anglo-Australian project will cost some $A 11,000,000.

The action in physics is moving from the laboratory to the cosmos, especially in high energy physics where it is no longer practicable to conduct some types of experiments in the laboratory. As an alternative, astronomers and astrophysicists are using telescopes and associated equipment to observe nature's vast experiments in space.

Although observers in the northern hemisphere have had giant optical telescopes such as the 200-inch instrument at Mount Palomar in California at their disposal for many years, the Australian National University's 74-inch telescope is currently the largest available for viewing those sections of the universe visible only from the southern hemisphere.

An Anglo-Australian policy committee for construction of the Siding Spring telescope was formed in 1967. The Australian representatives include the Director of the Mount Stromlo and Siding Spring Observatories (Professor O.J. Eggen) and the Chief of the Commonwealth Scientific and Industrial Research Organization's Division of Radiophysics (Dr. E.G Bowen). British astronomy is represented by the Astronomer Royal (Sir Richard Wooley) and Professor Fred Hoyle and Mr. J Hosie of the Science Research Council.

The mirror for the 150-inch telescope is being made of a revolutionary new material, a glass-ceramic with a negligible response to temperature changes The mirror blank, cast in the United States by Owens—Illinars, will shortly be shipped to England where it will be ground to the correct curvature by Grubb-Parsons Ltd. The contract for fabrication of the telescope itself will be negotiated in 1971. The complex is expected to be in operation by 1973.

Two smaller instruments are also planned to complement the main telescope. The first is a 48-inch Schmidt camera which is the subject of current negotiations between the Department of Astronomy of the Australian National University and the British Research Council. The second instrument required to complete the observatory complex is a 60-inch reflector.

In commenting on this ambitious project recently, Professor Eggen stressed its importance to astronomers and physicists. He said that the 150-inch telescope will certainly ensure the continuity of Australia's leadership in astrophysics Furthermore, he said the demonstration that the know-how and skills required to construct and operate telescope of this size are available

Australia underlines the technical advances made in that country in recent years.

Micro-Surgery

Surgeons at St Vincent's Hospital, Melbourne, are now working with the world's most sophisticated micro-surgical equipment It has been especially made or modified by Melbourne University medical technicians and local firms

The equipment combines a foot-operated microscope for use simultaneously by three surgeons and specially designed forceps, needle holders, sutures, scissors, nerve cutters and micro vascular clamps

This facility has enabled new micro-surgical techniques to be devised and successful projects have been undertaken in the fields of ophthalmology, plastic surgery, cardiac surgery and neuro-surgery. Thus, surgeons working at St Vincent's have sutured small blood vessels less than one millimetre in diameter.

This has enabled them to attain greater success in the replantation of severed parts in transplantation operations both clinical and experimental, and in cardiac coronary artery surgery.

Full technical details of the design of the equipment may be obtained from Mr B.O Brien, Department of Plastic Surgery, St. Vincent's Hospital, Fitzroy, Victoria, who directed and co-ordinated the efforts of the many people who contributed to this project

By Courtesy , Australian Information Service

What Happens to Detergents in the Sea ?

E J. PERKINS
Marine Laboratory, Garelochhead, Scotland

THE term "detergent'' is loosely applied to a variety of commercial products and to their surface active constituents. For clarity, it is essential to make a distinction between detergent and surfactant. The former is best reserved for commercial preparations, tailor-made for many uses, domestic and industrial, ranging from shampoos to oil emulsifiers. Detergents contain a variety of chemical compounds to give the product its desired properties, including a relatively small proportion of a surface-active agent or surfactant. These belong to four principal groups—anionic, non-ionic, cationic and ampholytic—and only the first two are of concern in the sea. Unlike the anionics, non-ionic surfactants are used more in industry than the home. Although most detergents released to the sea, usually with untreated sewage, contain anionic and non-ionic surfactants, it is the non-ionic ones, used as oil emulsifiers, that have produced the most spectacular effects.

While biological effects are important, the physical effects of these substances should not be ignored. Apart from lowering the surface tension, and reducing the uptake of oxygen from the atmosphere, they also lower wave heights. A strong onshore wind can transform the sea's edge into a persistent foam, at low concentrations of an anionic surfactant, though without apparent harm to littoral life

The influence of domestic detergents is not due to the surfactant portion alone The Great Lakes of North America are ageing at an accelerated rate partly because of the polyphosphates used to increase the surfactant's action, an enrichment not specifically reported on in marine waters, but which with untreated sewage must have an effect.

Marine life is sensitive to detergents, but the anionic and non-ionic surfactants are poisonous to a highly variable degree. The resistance of these organisms depends on species, age and habitat: shore dwelling

species are more resistant than those from below the low water mark The structure of the surfactant molecule and, in the case of the oil-emulsifiers, the type of solvent carrier influence toxicity to marine organisms. Furthermore, the surfactants, by their effect upon cell membranes, have a marked influence on the uptake of other chemical substances harmless or not

Recent emphasis upon "soft" detergent that can be broken down biologically, especially in relation to sewage works, has had an unknown impact in the sea, to which large amounts of untreated sewage are released and in which the rate of biodegradation is unknown. Inshore, a chronic exposure to surfactants can arise only near to a sewage effluent line, but most organisms will be exposed only from time to time because winds and tides vary Oil spills and similar industrial accidents do not happen often. In either context, the study of the effects of chronic exposure are largely irrelevant, whereas the influence of single or intermittent exposures at levels considerably below the median tolerance limit (TLm) are of great interest

In the sea, the gastropod and lamellibranch molluscs are particularly suitable for such studies. All of them have a non-living shell which can be V-notched and painted without harm to the living tissues and the growth rate, shown by the deposition of shell, can be measured readily. The history of such animals, after treatment, can be studied either by releasing marked animals to roam the shore at will, or by keeping them in live boxes suspended from buoys, or by a combination of these two methods

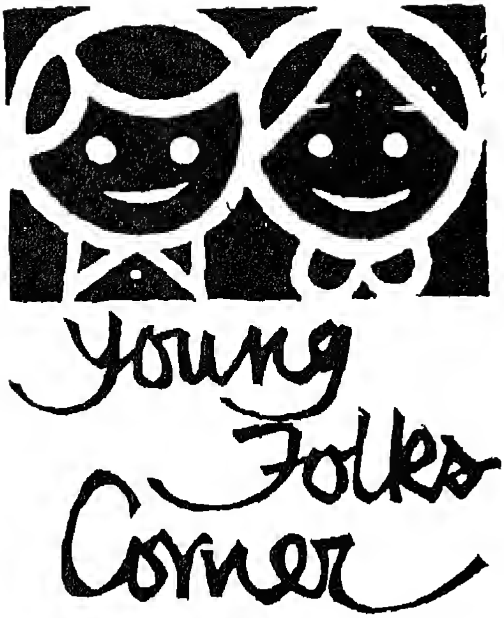
Single 24h doses of oil emulsifiers and of non-ionic surfactants alone, produced over 10-22 weeks, delayed mortality and inhibition of growth in the winkle, *Littorina littorea*, the rough periwinkle, *L saxatilis*, and the dog-whelk, *Nucella lapillus*; in the case of the rough periwinkle at $\angle$ 1/3000 TLm Similar studies, with a combination of live box technique and laying on commercial grounds have been possible with the oyster, *Ostrea*. Using the oyster and mussel, *Mytilus*, means that we can study the effect of such treatments on the condition factor (that is, the relationship between the relative proportions of flesh and shell: commercially acceptable condition factors for mussels are 35-40 per cent). Early results suggest that subjecting mussels to high sub-TLm concentrations of oil emulsifier may not have long term bad effects on their condition.

Exposure, though, may influence predatorprey relationships especially where the prey is immobile or sedentary. The rough peri-winkle is more susceptible to the green shore crab, *Carcinus maenas*, at doses as low as 1/30,000 TLm. The dog-whelk is significantly more susceptible to the whelk, *Buccinum*, when treated at about 1/100 TLm. Possibly, delayed mortality and increased susceptibility to predation after treatment with detergents is because cell contents are lost through modifications to the cell membranes caused by surfactants.

It is not easy to study the effects of detergents on reproduction in the sea. However, the fresh water gastropod *Physa* when dosed with 1 ppm *Essolvene* weekly, spawned earlier, laid larger egg masses, and died earlier than the specimens not treated It is reasonable to expect similar effects in the sea.

Generally, the response of living organisms to increasing toxin concentration is best expressed by a sigmoid curve. Detergents deviate a lot from this system and do not always produce a mortality in proportion to dose. Comparing three years experiments with surfactants or detergents and other substances such as mineral and orga-

nic acids and salts, (excepting those of aluminium), revealed that the difference in response was statistically significant at 0.1 per cent level. The variable toxicity of *aluminium* salts results from their characteristic self-precipitation. Increasing concentrations of non-ionic surfactants and detergents show a "pH" response with BDH Universal, Diphenol purple and Bromo-thymol blue indicators, but not with a glass electrode and pH meter. Similar changes occur in fresh water, but at much higher concentrations. This effect is apparently inexplicable in terms of CMC. However, the behaviour of aluminium suggests that a knowledge of the physical chemistry of surfactants in sea water would rationalise what we know of their toxicity, and the search for efficient, non-toxic oil-emulsifiers.



Snakes—the Specialized Reptiles

BUDH DEV SHARMA,
P.G. Deptt. of Zoology, Kashmir University, Srinagar

SNAKES are slippery creeping creatures. There are about 200 species of poisonous snakes out of 2,300 species of snakes in the world. Nevertheless, the vast number of snakes in a species, the world wide distribution of poisonous varieties and aggressive habits of them constitute a first class menace to life practically all over the world.

More than 100,000 persons die of snake bite in world every year. Dr. Frayer a British Physician in India concluded some years ago that probably 30,000 Indians die of snake bite every year. But many of these deaths are due to fright and wrong line of treatment. Newzealand is the only country in the world which has no snakes at all. Madagascar is the only large country which enjoys the total absence of poisonous snakes.

Snakes are most highly specialised of the reptiles in existence and poisonous serpents make the zenith of their specialisation. Not only have they limbs completely disappeared and the bony girdles which support them been completely lost, but a fantastic modification has taken place in almost all the organs of their body. The lungs, liver, etc. are extremely elongated and the salivery glands which in other animals secret the saliva for digestion of food get modified in some snakes to secrete a virulent poison that can kill even an elephant when injected into its blood stream. Their fatal poison and silent lurking habit, coupled with agility, compels to consider the poisonous snakes as deadliest enemies of mankind.

Among non-poisonous only a few are of negative importance as to destroy useful animals. The gaster snakes, water snakes, etc. feed on frogs, toads, fishes and other cold blooded animals. But a large number of these are useful to man as they destroy rats, white ants and other small enemies of human house hold. The snake accused of stealing the milk of cows, buffalows from their udders is Ptyas mucosus of India which is commonly known as Dhaman or rats snake. These snakes which are roughly named as milk snakes do not steal in real sense the milk from the udders of the cattle. Hence it is mere an idle fable about them.

Gharpure divided snakes into five big groups for practical purposes:

1. *Burrowing Snakes*: They live under ground and feed on earth worms, insect, etc.

The so called double headed snakes belong to this group They look double headed because their tail is short. The snakes in

this group are mostly non-poisonous e g. *Eryx conicus.*

2 *Tree Snakes:* They spend most of their lives in trees and bushes. They live on lizards, small birds and tree frogs. They are mostly harmless The saliva of some is mildly poisonous but has no serious effect on human beings e.g. Leptophis licceros, Dendrophis punctata.

3. *Sea Snakes* They are deadly poisonous. Their tails are flat and laterally compressed. Their nostrils are on the top of the snout to facilitate their swimming in water. They feed on fish e.g. Hydrophis obscura.

4. *Fresh water Snakes:* They feed on frogs and fish. Their nostrils are on the top of their snout so that they can breathe under water. They are non-poisonous e.g. Tropidonotus piscator

5. *Ground Snakes:* Most of the snakes that we see belong to this group They live on grounds They can climb trees and enter water but not normally. This group contains both poisonous and non-poisonous varieties including Cobras, Corals, Kraits and vipers. Dhamans and pythons are instances of the non-poisonous kind. These snakes have big heads and expandable mounts. They live on rats and squirrels e.g. Naja tripudian, Ptyas mucosus

The chief poisonous snakes are described as follows.

1. *Cobras:* There are ten species of cobras of which common Indian Cobra and King Cobra are found in India. The King Cobra is extremely poisonous. It eats other snakes (even big snakes) like other cobras and Kraits etc. In Naja naja the scales are smooth and disposed obliquely, the neck is dilated to form a hood length and is up to three and a half metres.

2. *Corals:* They are all poisonous, but their poison does very little harm to human beings. They are beautifully coloured. Their belly is of Colar colour. They are generally small size. There are nine species of these found in India and Burma.

3. *Vipers:* This group contains three hundred and ten species in the world. They are again subdivided into pit vipers and pitless vipers. Pit vipers are 65 in species and all of them are found in India. The pit vipers have distinct pit on the side of the head between eye and the nose. There are 45 species of pitless vipers and 7 are found in India The most important among them is *vipera russelli*, which is reddish brown with 3 longitudinal series of diamond shaped markings on the back and sides. The length is upto $1\frac{3}{4}$ metres. India is very rich in poisonous snakes. It is therefore, very useful to see whether the snake is poisonous or not.

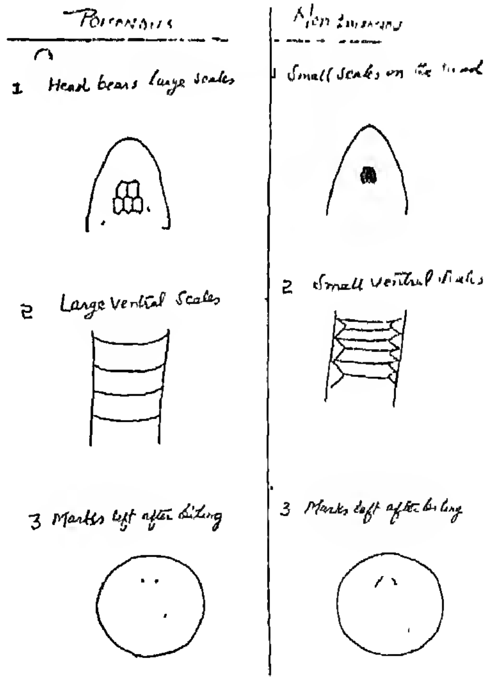


Fig. 1

The poison is produced in large glands which are placed on each side of the upper

jaw. Each gland is surrounded by a cloak of mussles and the poison is forced out when required. The poison is actually saliva containing venom in it This venom is sufficient to kill or paralyse the prey. The distinctive features between poisonous and non-poisonous snakes are as follows:

Poisonous	Non-poisonous
1. Scales on head are large and expended surface.	Scales are not prominent in head region.
2. Scales on the ventral of the body are very large and flattened.	Scales are very small on the ventral surface of the body.
3. Fangs present.	Fangs absent.
4. Both Maxilla and Pre maxilla are small	Maxillary bones greatly elongated.
5. The bite has two distinct fang marks.	The bite is in the form of scratches.

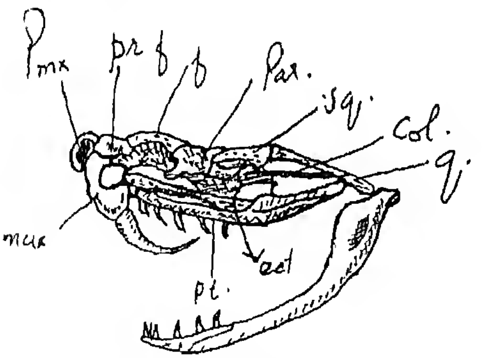


Fig. 2. Skull of Rattle-snake (Carotalus)

Fig 2 (a) Arrangement of Bones in Biting Apparatus of Poisonous Snakes

Mechanism of Biting: The apparatus of biting mechanism is formed by the upper jaw which is so constructed that by pushing forward the horizontal pterygoid bar, the short maxilla is rotated and erected through the intervention of the ectopterygoid or the transverse bone The fangs are automatically erected, when mouth is opened. The poison gland is compressed and the venom comes out and reaches the wound via duct and fangs. The bones which play an important role in the biting mechanism are maxilla transverse (ectopterygoid), pterygoid, quadrate and squamosal. The squamosal is horizontal and loosely attached to the skull. The quadrate is attached to squamosal. The transverse bone connects the maxilla and the pterygoid. The various bones

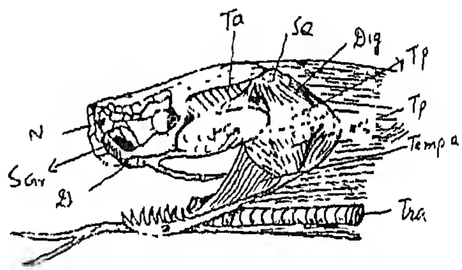


Fig. 3 Head of a poisonous snake after removal of the skin X 1 D, Duet, bent upon itself from the poison gland into the tooth; Dig, degastric muscle or opener of the jaw; N, nostril, P.G, Poison Gland, S Gr, Sensory groove or pit; S Q point of Junction of the squamosal and quadrate; T a, temp. a, anterior and T. P, Posterier, temporal muscle

are hinged together and are movable. When the mouth opens the first hinge between the squamosal and quadrate becomes vertical and the pterygoid bone is pushed forward. As a result of this the transverse bone is pushed upward and moves the maxilla so that fangs become vertical. The apex of the fang strikes against the prey. There is a syringe needle opening at the tip of each fang which is connected with the poison gland through a duct.

Economic Importance of Snakes

1. Some show men make their living by exhibiting them to the people.
2. Snakes are exported outside for zoos, exhibition, shows, etc.
3. The snakes are taken as delicacy by the people of some European countries.
4. Viper snake oil, Cobra snake oil and other varieties of snake oil are commonly recommended for some medical uses. These oils are roughly and wrongly named as "Ghee". In some parts of India like Rajasthan East, U.P and Bengal, the rats snake (*Ptyas mucosus*) which is commonly named as Dhaman is used for the extraction of medicinal snake fat for various ailments like rheumatism, sciatica, etc.
5. Skin of snakes is used in making things like scarfs, belts, show cases, hand bags, neck ties, etc. Shoes covered with snakes skins command a high price At the institute of Soapaulo (Brazil), the library books are bound with snakes' skin.
6. In India the exuvia (snake's skin) is demanded for various medicinal uses.
7. The venom of snake command high price. The cost of cobra venom is Rs. 120 per gram and that of Krait and Echis snake is Rs 250 per gram The venom is of great medicinal value.
8. Sadhus in Rajasthan take cobra venom in small doses as an intensifier of the intoxicants which they ordinarily take.

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Enzymes May Play Big Part in Treating Diseases

ENZYMES, the biochemicals currently used to prolong the life of beer and to improve detergents, may in future play an important part in diagnosis and treatment of diseases.

This glimpse of the research now going on into enzymes was given recently when a £500,000 production plant was opened at Maidstone (South-East England) by Whatman Biochemicals Ltd., the firm in Britain making highly purified enzymes.

There are numerous potential uses for enzymes which have yet to be fully developed Their use as therapeutic drugs, for instance, has not yet been established

"But current research indicates that in the future enzymes will provide a means for treating a number of diseases," Mr. Knight said, "We expect advances in medical and scientific research to result from the opening of this new plant."

The new Whatman complex will work with British University laboratories to bring research to a commercial level. The plant is said to be the most modern of its type and will supply biochemicals to other countries as well.

By Courtesy—British Information Service

Meaning of the U.S. Environmental Report

WALTER FROEHLICH

THE U.S. Government's first annual report on environmental quality is perhaps the most massive compilation of environmental information, analyses and recommendations ever put under one cover.

It reveals more precisely and in greater detail than ever before the attitude and approaches that have been evolving at the highest level of the U.S Government to meet environmental problems.

The report (released in Washington last week) constitutes a search for a new understanding between man and his environment, a new experiment in man's relations with his surroundings.

The report has stressed the need for setting environmental priorities as part of its programme for a better America. "The process of setting priorities is difficult," the report noted, adding: "There is a deep conflict over which problems are most important. And the inertia of on-going activities is a major obstacle."

"Whatever the divergences, diligent application of priorities will be necessary to make any real progress towards a high-quality environment"

For these reasons, it has significant global implications

Technologically advanced nations, almost all of whom have the same environmental problems as the United States, may find the report useful for possible adaptation to their own needs.

Developing nations, whose environmental problems are different, may gain clues from the report on how to avoid or mitigate problems that will emerge as they industrialise.

The report arrived during a great national debate in the United States on how best to organise a governmental framework and forge the legal and other institutional tools for coping with growing environmental problems.

In the United States as in many other nations, environmental problems have become more acute through increases in population, per capita consumption and sophistication in technological processes.

As this degradation has become more noticeable, public concern has mounted and has been accompanied by a psychological shift in values. The American aspiration for an ever higher material "standard of living" has been augmented by a desire for an ascending "quality of life."

Waste by-products of manufacturing and consumption have grown in quantity and make-up and require more complicated and costly disposal methods than before. Also, remedies to many environmental problems have become available and the public is demanding that they be used.

In a sense, the people of the United States, through this government report, have looked into a mirror, objectively and unashamedly Both good and bad are reflected

The report is based on the assumption that recognition of shortcomings is a useful first step towards improvement. In U.S history, technological progress has often been motivated by dissatisfaction with conditions Disenchantment with the environment may now trigger effective.

The report offers Americans a wide spectrum of feasible remedies rather than a single take-it-or-leave-it solution. Ultimately, the people will decide on which part of the specturm to focus

Through their elected representatives, they will have to determine what kind of environment they want and how much they are willing to pay for it.

News

Science Films

THE film is being increasingly recognized as a very powerful teaching aid for effective instruction in science. The Department of Science Education is wedded to the idea of improving science education in this country and it has very appropriately embarked on a programme of science films. The first in the series entitled "A New Approach to Primary Science Teaching" is at present under preparation This is meant to highlight the main factor in science teaching, namely **Science is Doing**. In this film emphasis is on the "process" of teaching science and not the "product". The second film would be on "Teaching of Elementary Physics" for the science teachers of the middle schools,

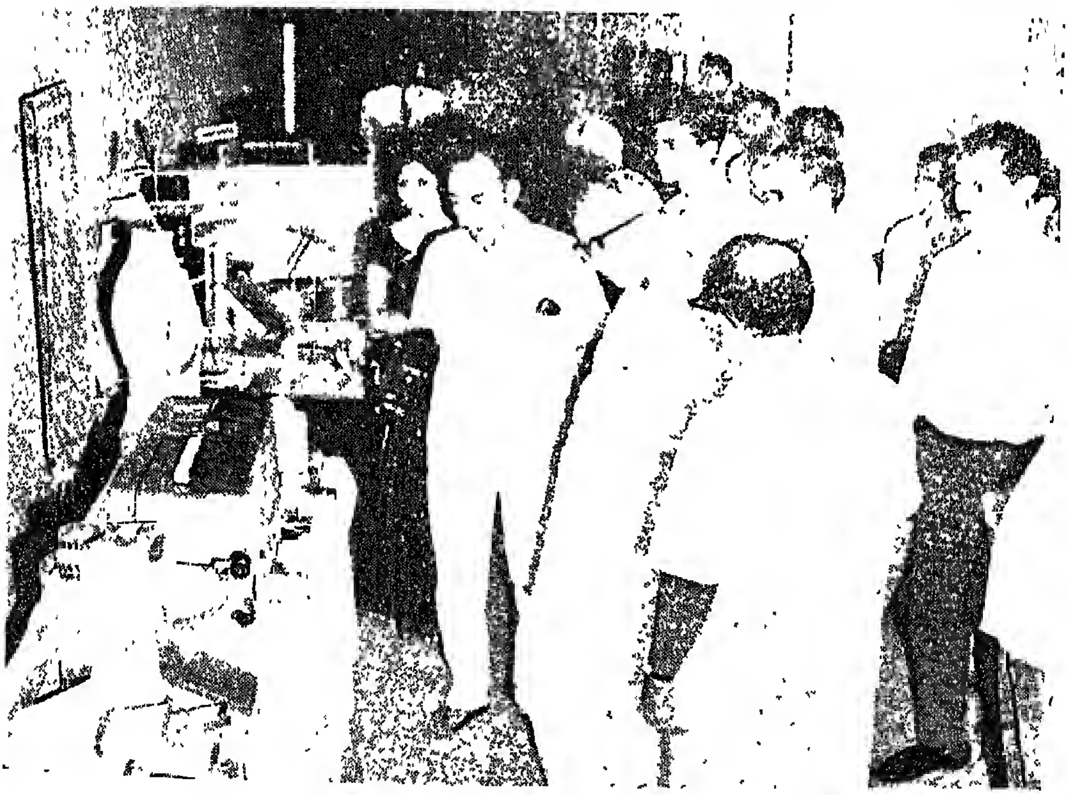
Exhibition of Instructional Materials in Science

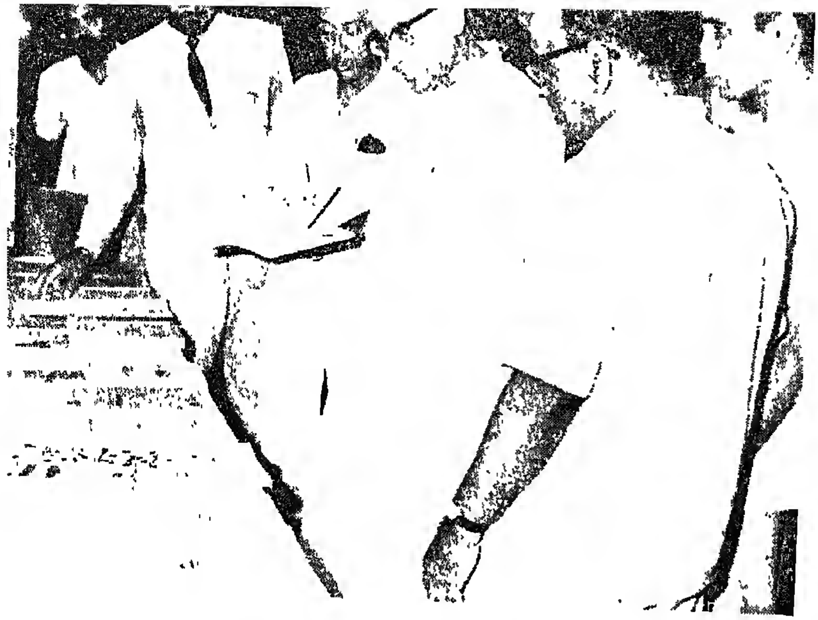
THE Department of Science Education in the National Council of Educational Research and Training is now engaged in some projects for the improvement of science education in schools all over the country. They have already come to a stage where they have produced a good deal of instructional materials like text materials, teachers guides, teachers handbook of activities, and have also developed science kits for the Primary Science as well as for the middle school. Recently a conference of Secretaries of Education in the States and Directors of Public Instruction was held at Vigyan Bhawan on 10th and 11th of August, 1970. Taking advantage of the venue of this conference the Department got up an exhibition of instructional materials in science in the lobby of Vigyan Bhawan. The aim of this exhibition was to bring to the notice of the Secretaries and Directors of Public Instruction the details of science teaching projects undertaken by the Department as well as details of assistance given by the Ministry of Education, Government of India to the different States under the UNICEF/UNESCO Assistance Scheme.

Under this scheme, 50 primary schools and 30 middle schools in each State and Union Territory would be provided with all the instructional materials like textbooks, teachers guides, handbook of activities for teachers, training materials, science kits, science equipment and teaching aids like

Exhibition of Science Materials

Prof. V K R.V. Rao, Education Minister, viewing the equipment to be given to Key teacher Training Institutes of States and Union Territories.



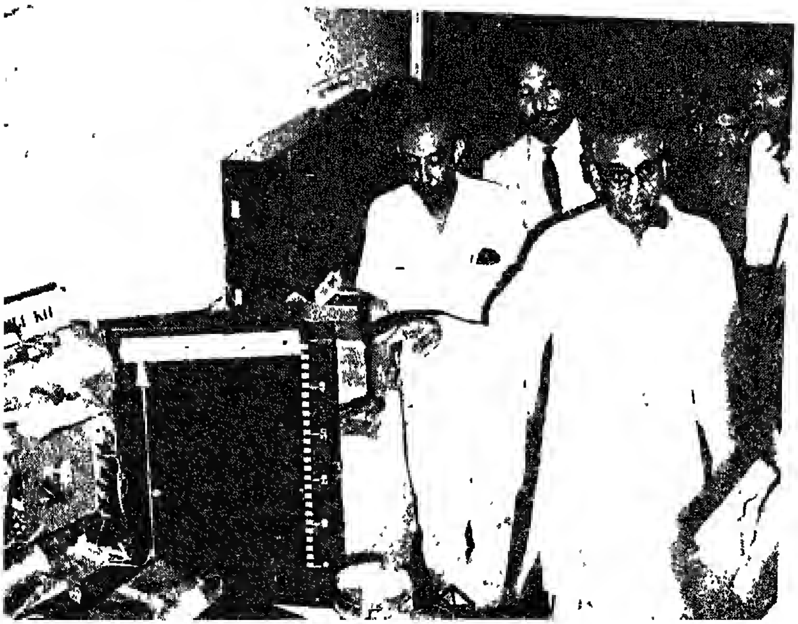


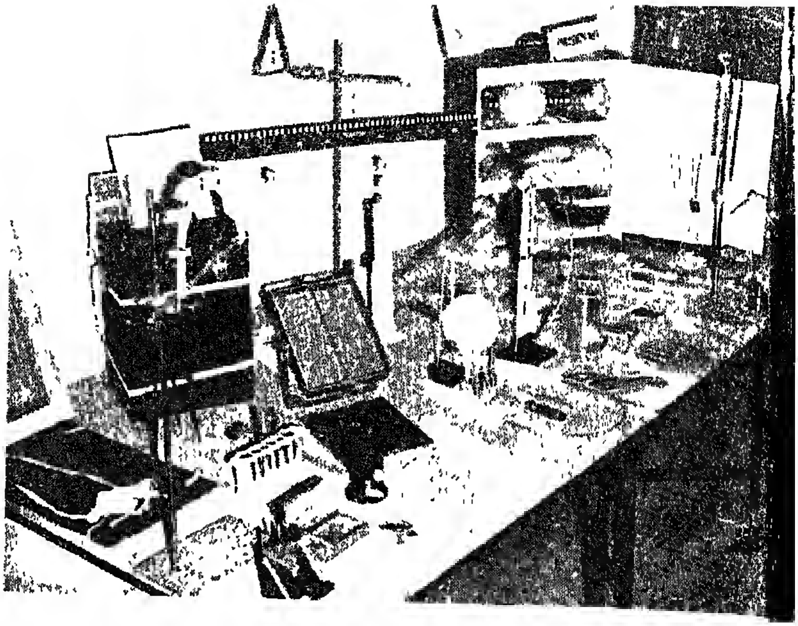
The Education Minister examining the science instructional materials published by NCERT

Dr. M.C Pant explaining the parts of Primary Science kit to the Secretaries of Education of States

Another view of Primary Science kit to be supplied to schools in the States

Prof Rao showing keen interest in the Primary Science kit





A view of physics demonstration kit and the biology kit for middle schools

A view of the items of equipment to be supplied to the States under the UNICEF/UNESCO scheme. Prof S.V.C Arya is seen explaining the parts to the Minister for Education

Dr Pant showing the working of simple optical bench device made by the Department of Science Education.

The Minister looking at various publications of the science text materials.

charts, slides and film -strips. The cost of the training of teachers and the preparation of the text and teachers guides in the different regional languages would also be met by the Ministry of Education under the scheme. The training of key-persons from the State Institutes of Education has already been undertaken by the Department of Science Education. In June, 1968 the key-personnel were given a one-month intense inservice training in the Department. The key-institutions in the States would also be provided with sufficient equipment for the training of science teachers.

There were a number of visitors to view the exhibits in the exhibition The highlight of the exhibition was the visit of the Hon. Minister for Education, Dr. V.K.R.V Rao on the first day of the conference. He appreciated the work done so far by the NCERT and the Department of Science Education He also stressed the need for popularising such science kits which could reach out to every primary school both in the rural areas as well as in the urban areas

Among the visitors were the Secretaries of Education in State Departments of Education and the Directors of Public Instruction/ Directors of Education Prof. S.C.V. Aiya and Dr. M.C. Pant, Head of the Department of Science Education were there explaining the features of the materials prepared to important visitors. The Secretary of Education in the Ministry of Education Shri S. Chakravarti and the Joint Secretary Shri T.R. Jayaraman also visited the exhibition The exhibition was got up by the Department of Science Education and the Central Science Workshop of the Department with considerable help from Department of Teaching Aids. Shri K.S. Bhandari, in charge, Instructional Material Centre, Shri P.K. Bhattacharya and Shri A.P. Veram from the Central Science Workshop and Shri N.P. Bhattacharya from the Department of Teaching Aids were largely responsible for putting up the exhibits. A set of photographs taken of the exhibits and the visitors may be seen in this issue.

Primary Science Project; and Project for Improvement of Science Teaching in Secondary Schools

THE development of instructional materials for this project continues The Teachers Guide in Hindi and English corresponding to the textbook 'Science is Doing' for Class III, has been published. A few chapters of the draft of textbook for class IV have been technically reviewed and edited within the Department.

The UNICEF/UNESCO assisted pilot project has already started functioning from the academic session starting in June/July, 1970 in 50 primary and 30 selected middle schools in most of the States. The Department is responsible for providing all instructional materials, equipment and technical assistance to the States for this project. The following States were supplied a complete set of science equipment received from the UNESCO containing about 460 items and also the Primary Science Kit, Physics Kit No. 1 and Biology Kit No. 1 for middle stages

State	*Primary Kits*	*Middle School Physics & Biology Kits*
Gujarat	30	30+30
Mysore	50	26+26
Kerala	51	31+31
Rajasthan	51	27+27
Haryana	51	31+31

Delhi	30	— —
J & K	40	40+40
Punjab	51	31+31
Andhra Pradesh	51	31+31
Madhya Pradesh	51	31+31
Himachal Pradesh	26	11+11
Maharashtra	46	46+46
Uttar Pradesh	51	31+31

Supply of textbooks for the UNICEF Project to the following Hindi-speaking States was made

State	*No of copies supplied (Hindi)*		
	Class III Science is doing	Class VI Physics Part I	Class VI Biology Part I
Rajasthan	4500	3500	3500
Madhya Pradesh	2600	5260	5260
Uttar Pradesh	3500	2500	2500
Himachal Pradesh	425	425	425
Haryana	3500	2100	2100
Delhi		3000	(100) supplied
Maharashtra	0	50	50
(English edition)	10	10	10

The kits were manufactured in the Central Science Workshop of the Department from indigenous materials, and they support the new curricula

The UNICEF had supplied equipment for 79 key institutions which were received in the three ports of Bombay, Madras and Calcutta These packages were checked at the ports and arrangements were made for their despatch to different institutions Some extra sets of illustrations for the Class III, and Class VI, text materials were supplied to some States for their use in bringing out the language versions of these books for their experimental schools

Film and Film-strips

Two sets of coloured transparencies one on "Teaching of Science at the Primary Schools" (consisting of 49 slides) and the other on "Teaching of Physics in the Middle Schools" (consisting of 37 slides) were prepared in collaboration with the Department of Teaching Aids and 100 copies of each set have been prepared for supply to the States for their Teacher Training Programmes

The film is being increasingly recognized as a very powerful teaching aid for effective instruction in science. The Department of Science Education is wedded to the idea of improving science education in this country and it has very appropriately embarked on a programme of science films

Scripts of two films for training, (1) on "New Approach to Primary Science Teaching" and (2) "Teaching of Physics at the Middle Schools" were finalized and the shooting was started Some rough prints have been obtained The films are expected to be ready by the end of the year Discussions are already afoot with the Film Institute of India seeking their collaboration for the preparation of other Science Teaching Films

Study Groups

After completing their work of preparing teaching materials including textbooks and teachers guides for the middle schools the Study Groups have now begun on the preparation of similar materials for the High Schools

Mathematics· A Meeting of the Mathematics Study Groups was held in Kanpur in December to discuss and finalize revised draft materials for the first year of the high school stage

Printing of Geometry Part I and III have been completed and Part II is under print Similarly, the printing of Algebra Part I for the middle stage is nearing completion. The Teachers Guide of Algebra Part I has been finalized.

Biology. The draft textbooks for Parts IV to VI have been finalized The Teachers Guide for these parts have also been finalized and the same would be discussed at a meeting of the Study Groups to be held in October, 70 in Madras Out of the three supplementary one is under print and another is already with the Publication Unit for processing.

Physics. A try-out for Part I of Physics for the middle schools has been undertaken in three Delhi schools from the beginning of this academic year Preparation of textbook for Part III is in progress. A limited number of Physics Kit Part I is being duplicated by the Central Science Workshop for views and try outs in experimental schools

Chemistry: Two meetings of the Study Groups have taken place, one at Poona and the second at Chandigarh where text and laboratory manual for the first year of the high school are discussed. Some of the chapters have been re-assigned for amendment and discussion.

Orientation Programme for State Institutes of Science

A plan has been drawn up for a training programme of the key personnel of some States in order to orient them with the primary and middle school materials. This training course will be organized in October 1970

National Science Talent Search Scheme

The new awardees for the year 1970 were intimated about their selection for scholarships, and preparations have already been started for constructing the selection tools for the next year's examination. Adequate publicity has been given for the next examination through all leading newspapers of the country in English and regional languages. Provision has been made for the direct supply of forms to individual applicants in addition to the normal institutional demands

The information brochure for the next examination 1971 has been printed.

Instructional Material Centre

A list of equipment needed for a mobile science van has been drawn up and the dimensions of various constructions inside the van have been decided. The first proto-type of the van would be developed in the next few months

Designs of laboratories for future training schools and teacher training colleges have been finalized

School Science

The combined issue of *School Science* March-June 1970 (Vol 8 Nos. 1 and 2) has been brought out

Central Science Workshop

The Central Science Workshop of the Department is busy in producing packages for the despatch of the Physics, Biology and Primary Science Kits. About 1000 kits for the primary schools and 500 kits each of Physics and Biology for the middle schools were prepared. Over 500 primary kits and nearly 300 middle school kits have been distributed to the various States The preparation of Kit II for Physics for middle schools, and proto-types of kits for Physics and Chemistry for high school stage is continuing

International Conferences

On the invitation extended by the Director General of the International Union for Conservation of Nature and Natural Resources, the National Council of Educational Research and Training deputed Shri S.

Doraiswami to participate in the International Working Meeting on Environmental Education in the School Curriculum organized by the IUCN as part of the UNESCO's "International Education Year" at the Foresta Institute for Ocean and Mountain Studies in Carson city, Nevada, USA held between June 20 to July 10, 1970 The purpose of the Working Meeting was to gather representatives from the UNESCO's Member-States for study of environmental curricula appropriate to the needs of world youth A proper incorporation of Environmental Education into school curricula at primary and secondary level is one of the key-components of the sustained system of modern Environmental Education

The recent 10th General Assembly and Technical Meeting of the IUCN held in December 1969 in Delhi brought into focus the urgency and necessity for emphasising Conservation Education in our school curricula. There were about 22 participants in the meeting These delegates hailed from 15 countries. Besides the delegates there were the Director of the Foresta Institute and representatives from UNESCO and IUCN

Shri S Doraiswami read a paper at this meeting on "Environmental Education in the Curricula of Indian Schools" He also exhibited the various text materials and curricular materials prepared by the NCERT at the conference hall The delegates evinced keen interest on the lecture and the curricular materials exhibited, and several questions were asked about the working of the science teaching project The delegates from other developing countries were particularly interested to know how this project is being worked out in India. Shri S Doraiswami emphasised the areas in their curricula where concepts on Conservation Education and Environmental Education are stressed.

Shri S. Doraiswami also presided over the Working Group IV which dealt with "Starting and Improving Environmental Education in School Curricula". This Committee drew up detailed areas on different disciplines which should be dealt with in the textbooks to emphasise concepts of Environmental Education The report of Group IV formed the main bulk of the final draft report drawn up by the conference. Shri Doraiswami was also asked to chair the Committee to prepare draft resolutions and recommendations On the whole, the Conference was successful and the recommendations and reports of the conference would be found extremely helpful to the member-countries. Shri S Doraiswami, who has already been elected as Member of the Commission on Education of the IUCN, was asked to organize an Indian Regional Committee and draw up plans and programmes for the work of Environmental Education in the country Ultimately a regional meeting of the nature of the meeting that was held in Carson city would be organized.

UNESCO Fellowship Programme

Shri K V Rao and Shri H L Sharma who had gone to the USSR under this scheme for a period of four and five months respectively have returned after completing their training. Mr. Rao went for the study of Mathematics Education and Shri H.L Sharma for Physics Education. They both studied also the Teacher Training Programme in their respective subjects. Miss S. Majumdar of the Biology Department had also gone to Russia under the same programme After completing the programme she has now proceeded to the U.K under the Commonwealth Bursary Scheme.

Collaboration with States

The Staff Members of Department of Science Education acted as resource persons in the States which organized their teacher training programme for the teaching of the new science courses. Two such programmes were assisted in the States of Madhya Pradesh and Gujarat where teachers of primary and middle schools were undergoing training

Staff of the Department

Shri T.R. Kapoor formerly of the Delhi College of Engineering joined as the Technical Superintendent of the Central Science Workshop of the Department in the month of September 1970.

Publications

During the three months the following books were printed.

1. Physics Part I for middle classes (Revised edition, English version).
2. Bhautiki Bhag I for middle classes (Revised edition, English version).
3. Biology Part I for middle classes (Revised edition, English version).
4. Jeev Vigyan Bhag I (Revised edition, Hindi version).
5. Science is Doing for Class III, (English version).
6. Vigyan Kar Ke Sikhe, (Hindi version)
7. Teachers Guide for Science is Doing Class III, (English version)

Exhibition

A special exhibition of Science equipment and instructional materials being supplied to the States under the Department's science teaching projects was organized at Vigyan Bhawan during the annual conference of the Directors of Education and Secretaries of State Education Departments. An account of this exhibition and pictures of the same may be found elsewhere in this issue.

Visitors

A number of Indian and foreign experts visited Instructional Material Centre of the Department and its Workshop and Laboratories and were acquainted with the various works and programmes of the Department. One kit developed for Primary Science from indigenous material was given to the UNESCO expert from Nairobi.

Problems in Mathematics

J N. KAPUR
Indian Institute of Technology Kanpur
and
R C SHARMA
Department of Science Education
N C E.R T.

SS46 A die consists of a cube which has a different colour on each of its 6 faces.
   (i) How many distinguishably different kinds of dice can be made?
   (ii) How many different ways are there to make a pair of dice?

SS47 Each face of a regular Octahedron is to be given a different colour If eight different colours are available, how many distinguishable Octahedra can be made?

SS48 A pentomino is a figure made of five squares placed so that each square has a common side with some other square Two pentominoes are congruent if one can be placed on the other so as to coincide with it How many different (non-congruent) pentominoes are there?

SS49 Enumerate all non-congruent hexominoes Shade consecutive squares in different shades and find how many of them contain equal number of different shaded squares and how many contain an unequal number?

SS50 Obtain all possible solid polyminoes made from cubes in such a way that each cube touches one other along a face How many solid pentominoes can be made?

SS51 Draw all possible quasitetrominoes i.e figures formed of four squares each of which touches some other along an edge or at a vertex

SS52 Draw all possible solid pseudotriminoes i.e. figures formed of three cubes, each of which touches some other along a face or an edge or at a vertex

SS53 Draw all possible heptiamonds i e figures formed of seven equilateral triangles each of which touches some other along an edge

SS54 Draw all possible figures formed of five regular hexagons each touching some other along an edge.

SS55 (i) Arrange 12 pentominoes into 5×6 rectangles of 6 pentominoes each.
   (ii) Arrange the 12 pentominoes in 8×8 squares pattern with a 4-square hole in the middle so that the pieces separate into 2 congruent parts, each using 6 of the pentominoes.
   (iii) Divide the 12 pentominoes into 3 groups of 4 each Find out 20-square region tht each of the three groups will cover.

Solutions to Problems in Mathematics

SS 11. If $a_1, a_2, a_3, \ldots, a_n$ are positive numbers whose sum is A, then show that

$$a_1, a_2+a_2\ a_3+a_3\ a_4+\ldots\ldots+a_{n-1}a_n \leq \frac{A^2}{4}$$

Solution. If A and B are real numbers $(A+B)(A-B)=A^2-B^2\leqslant A^2$, since $B^2\geqslant 0$. Put $A=a_1+a_2+\ldots+a_n$ and $B=a_1-a_2+a_3-\ldots+(-1)^{n-1}a_n$ Then $A+B=2(a_1+a_3+\ldots)$, the sum of all a's with odd subscripts and $A-B=2(a_2+a_4+\ldots)$, the sum of all a's with even subscripts.

Hence $4(a_1+a_3+a_5+\ldots)(a_2+a_4+a_6+\ldots)\leqslant A^2$.

Multiplying out the two expressions in parentheses yields all possible terms a_ia_j with one subscript odd and one even. Included among these are a_1a_2, a_2a_3, ..., $a_{n-1}a_n$ and if $n>3$, others as well, all of which are positive Omitting these other terms makes the L.H.S even smaller, hence $a_1a_2+a_2a_3+\ldots+a_{n-1}a_n\leqslant(a_1+a_3+\ldots)(a_2+a_4+\ldots)\leqslant A^2/4$.

SS 12 The following are n simultaneous equations in the unknowns.

$x_1, x_2, \ldots, x_n$

$$x_1+x_2+x_3+x_4=0$$
$$x_2+x_3+x_4+x_5=0$$
$$x_3+x_4+x_5+x_6=0$$
$$x_4+x_5+x_6+x_7=0$$
$$\ldots\ldots\ldots$$
$$x_{n-3}+x_{n-2}+x_{n-1}+x_n=0$$
$$x_{n-2}+x_{n-1}+x_n+x_1=0$$
$$x_{n-1}+x_n+x_1+x_2=0$$
$$x_n+x_1+x_2+x_3=0$$

For what values of n do these equations have a unique solution? When the solution is not unique, write down the general solutions.

Solution. From the first two equations $x_1=x_5$. From the second and third equations $x_2=x_6$. From the third and fourth equations $x_3=x_7$. From the fourth and fifth equations $x_4=x_8$ and so on, so that we get:

$$x_1=x_5=x_9=x_{13}=\ldots\ldots$$
$$x_2=x_6=x_{10}=x_{14}=\ldots\ldots$$
$$x_3=x_7=x_{11}=x_{15}=\ldots\ldots$$
$$x_4=x_8=x_{12}=x_{16}=\ldots\ldots$$

From the last two equations of the given set $x_{n-1}=x_3$.
Similarly $x_{n-2}=x_2$, $x_{n-3}=x_1$ and so on that

$$x_{n-3}=x_1=x_5=x_9=x_{13}=\ldots\ldots$$
$$x_{n-2}=x_2=x_6=x_{10}=x_{14}=\ldots\ldots$$
$$x_{n-1}=x_3=x_7=x_{11}=x_{15}=\ldots\ldots$$
$$x_n=x_4=x_8=x_{12}=x_{16}=\ldots\ldots$$

The following four cases arise:
When $k=1, 2, 3, 4, \ldots$

(i) $n=4k$, all the four equations are satisfied by

$$x_1=x_5=x_9=x_{13}=\ldots\ldots=a$$
$$x_2=x_6=x_{10}=x_{14}=\ldots\ldots=b$$
$$x_3=x_7=x_{11}=x_{15}=\ldots\ldots=c$$
$$x_4=x_8=x_{12}=x_{16}=\ldots\ldots=-(a+b+c)$$

(ii) $n=4k+1$ when $k=1, 2, 3, 4, \ldots$ then we get from the above equations:

$$x_{4k-2}=x_1,\ x_{4k-1}=x_2,\ x_{4k}=x_3,\ x_{4k+1}=x_4$$

so that $x_2=x_3=x_4=x_5=x_1$
and since $x_2+x_3+x_4+x_5=0$,

the only possible solution of the system is
$x_1=0,\ x_2=0,\ x_3=0,\ x_4=0,\ldots\ldots$
i.e. $x_i=0$ for $i=1, 2, 3, 4, \ldots\ldots$

(iii) $n=4k+2$, when $k=1, 2, 3, 4, \ldots$ then we get from the above equations

$$x_{4k-1}=x_1,\ x_{4k}=x_2,\ x_{4k+1}=x_3,\ x_{4k+2}=x_4$$

so that

$$x_3=x_1,\quad x_2=x_4,$$

but $x_1+x_2+x_3+x_4=0$ or $x_1+x_2=0$

so that the solution is

$$x_1=x_3=x_5=x_7=\ldots\ldots=a$$
$$x_2=x_4=x_6=x_8=\ldots\ldots=a$$

(iv) $n=4k+3$, when $k=1, 2, 3, 4, \ldots$ then we get from the above equations:

$x_{4k}=x_1$, $x_{4k+1}=x_2$, $x_{4k+2}=x_3$, $x_{4k+3}=x_4$

so that

$x_1=x_4$, $x_2=x_1$, $x_3=x_2$, $x_3=x_4$

or

$x_1=x_2=x_3=x_4$

and since $x_1+x_2+x_3+x_4=0$;

the only possible solution of the system is $x_i=0$ for all i. Thus when n is odd, we get only one solution in which all the variables are zeros When n is even, we get an infinity of solutions.

SS13. All the even integers beginning with 2 are written successively as (2 4 6 8 10 12 14 16 18 20 . ....). Which digit occupies the 100000th position? Which digit will occupy the 100000th position if all multiples of 3 are written in the same manner?

Solution. One digit even integers are from 2 to 8 and their number is $\frac{8-2}{2}+1=4$

Two digit even integers are from 10 to 98 and their number is $\frac{98-10}{2}+1=45$

Three digit even integers are from 100 to 998 and their number is $\frac{998-100}{2}+1=450$

Four digit even integers are from 1000 to 9998 and their number is $\frac{9998-1000}{2}+1=4500$

Five digit even integers are from 10000 to 99998 and their number is

$$\frac{99998-10000}{2}+1=45000$$

Number of positions occupied by one digit even number $=4$

Number of positions occupied by two digit even number $=90$

Number of positions occupied by three digit even numbers $=1350$

Number of positions occupied by four digit even number $=18000$

Number of positions occupied by five digit even numbers $=225000$

Number of positions occupied by 1, 2, 3, 4 digit numbers $=19444$

Number of positions available for 5 digit numbers $=80556$

we can get 16111 complete numbers of 5 digits starting with 10000

Last number of this class

$$=10000+(16111-1)\ 2$$
$$=10000+32220$$
$$=42220$$

The next even number

$$=42222$$

and so the 100000th position is occupied by 4

Second Part

One digit numbers which are multiples of 3 are from 3 to 9 and their number is

$$\frac{9-3}{3}+1=3$$

Two digit numbers which are multiples of 3 are from 12 to 99 and their number is

$$\frac{99-12}{3}+1=30$$

Three digit numbers which are multiples of 3 are from 102 to 999 and their number is

$$\frac{999-102}{3}+1=\frac{897}{3}+1=300$$

Four digit numbers which are multiples of 3 are from 1002 to 9999 and their number is

$$\frac{9999-1002}{3}+1=\frac{8997}{3}+1=3000 \text{ and so on.}$$

Number of positions occupied by one digit multiples of $3=3$

Number of positions occupied by two digit multiples of $3=60$

Number of positions occupied by three digit multiples of 3 = 900

Number of positions occupied by four digit multiples of 3 = 12000

Number of positions occupied by five digit multiples of 3 = 150000

Number of positions occupied by 1, 2, 3, 4 digit numbers = 12963

Number of positions available for 5 digit numbers = 87037

We can get 17407 complete 5 digit numbers

Last number of this class = 10002+(17407—1)×3

= 10002+52218

= 62220

The next number is = 62223

The 100000th position is occupied by 2.

SS 14. (i) NINE —TEN = TWO (ii) SEVEN —NINE = EIGHT

$$\begin{array}{r} \text{NINE} \\ -\text{TEN} \\ \hline \text{TWO} \end{array} \qquad \begin{array}{r} \text{SEVEN} \\ -\text{NINE} \\ \hline \text{EIGHT} \end{array}$$

Find what digits should replace the letters so that the above subtraction sums may be correct.

Solution:

(i) It is obvious the N has to be 1, then we get

E = 1+0, 11—5, E = W, 9+I = 2T

The solutions of the last equation are I = 1, T = 5; I = 3, T = 6; I = 5, T = 7, I = 7; T = 8, I = 9, T = 9. The first solution has to be rejected because I≠N and the last has to be rejected since this gives I = T We shall, therefore, consider the possibilities (3,6), (5,7), (7,8) only

(a) If E = 2, O = 1 but O≠N. No solution exists in this case.

(b) If E = 3, O = 2, W = 8, I = 5, T = 7 gives the solution

$$\begin{array}{r} 1513 \\ -731 \\ \hline 782 \end{array}$$

(c) If E = 4, O = 3, W = 7. No solution exists in this case.

(d) If E = 5, O = 4, W = 6, I = 7, T = 8 gives the solution

$$\begin{array}{r} 1715 \\ -851 \\ \hline 864. \end{array}$$

(e) If E = 6, O = 5, W = 9. No solution exists in this case.

(f) If E = 7, O = 6, W = 4. No solution exists in this case.

(g) If E = 8, O = 7, W = 3. No solution exists in this case.

(h) If E = 9, O = 8, W = 2, I = 3, T = 6 gives the solution

$$\begin{array}{r} 1319 \\ -691 \\ \hline 628. \end{array}$$

I = 5, T = 7 gives the solution

$$\begin{array}{r} 1519 \\ -791 \\ \hline 728. \end{array}$$

(i) Arguing in the same way, we get the solution

$$\begin{array}{r} 21514 \\ -4641 \\ \hline 16873. \end{array}$$

SS 15. Fill the numbers in the hexagons below so that the sum of every row of 3 hexagons is 30, of every row of 4 hexagons is 40 and of every row of 5 hexagons is 50 The row can be horizontal or inclined

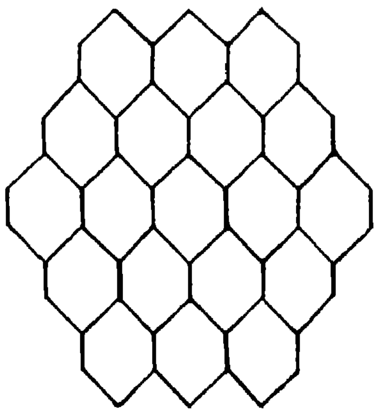


Fig. 1

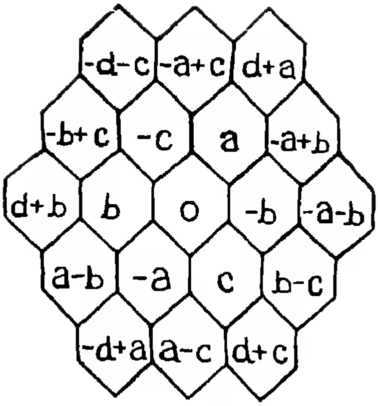


Fig. 2.

Solution:

We first construct a hexagon in which the sum of every row is zero. An algebraic solution is given in Fig. 2.

If we add 10 to every cell we get an arrangement with the required property.

If we want the entries to be integers 1 to 9, we note it will be sufficient to try value of a, b, c such that $O < a < b < c < o$ so as to make them—9 to +9 and then add ten to each entry.

Testing, we find 6 basic solutions

	1	2	3	4	5	6
a	1	1	1	2	2	4
b	5	—5	—6	—6	7	5
c	8	—8	—8	—7	8	7
d	1	1	3	3	—11	—13

Using the first solution (1, 5, 8, 1) and adding 10 to each cell, we get one basic solution given in figure 3

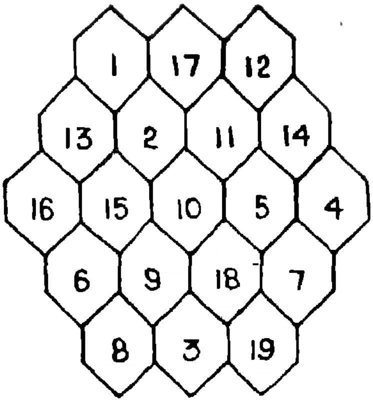


Fig. 3.

We can similarly get 5 more basic solutions

From these basic solutions, further solutions can be obtained by

(a) rotation through multiples of 60°

(b) reflections about a diameter

(c) interchange of corner terms of the outer ring with the adjacent terms of the inner ring.

Thus we get 144 distinct basic solutions.

SS 8· (Modified) Express all the numbers from 1 to 100 using exactly four fours and some or all of the signs +,—, ×, ÷, decimals, square root and factorial.

Solution:

$1 = 44/44$

$2 = 4/4 + 4/4$

$3 = 4/4 + 4 - \sqrt{4}$

$4 = 4 + 4 - \sqrt{4} - \sqrt{4}$

$5 = 4/4 + \sqrt{4} + \sqrt{4}$

$6 = \sqrt{4} + \sqrt{4} + 4 - \sqrt{4}$

$7 = \dfrac{4}{4} + 4 + \sqrt{4}$

$8 = \sqrt{4} + \sqrt{4} + \sqrt{4} + \sqrt{4}$

$9 = 4 + 4 + 4/4$

$10 = 4 + \sqrt{4} + \sqrt{4} + \sqrt{4}$

$11 = \dfrac{44}{\sqrt{4} + \sqrt{4}}$

$12 = 4 + 4 + \sqrt{4} + \sqrt{4}$

$13 = \dfrac{44}{4} + \sqrt{4}$

$14 = 4 + 4 + 4 + \sqrt{4}$

$15 = \frac{44}{4} + 4$

$16 = 4 + 4 + 4 + 4$

$17 = 4 \times 4 + 4/4$

$18 = \frac{44}{\sqrt{4}} - 4$

$19 = 4 \times 4 + \sqrt{\frac{4}{4}}$

$20 = 4 \times 4 + \sqrt{4} + \sqrt{4}$

$21 = 4! + \frac{4}{4} - 4$

$22 = 4! + 4 - 4 - \sqrt{4}$

$23 = 4! - \frac{\sqrt{4} + \sqrt{4}}{4}$

$24 = 4 \times 4 + 4 + 4$

$25 = 4! + \frac{\sqrt{4} + \sqrt{4}}{4}$

$26 = 4! + \sqrt{4} + 4 - 4$

$27 = 4! + 4/4 + \sqrt{4}$

$28 = 4! + 4 + 4 - 4$

$29 = 4! + 4 + 4/4$

$30 = 4! + \sqrt{4} + \sqrt{4} + \sqrt{4}$

$31 = 4! + 4 + \sqrt{\frac{4}{4}}$

$32 = 4! + 4 + \sqrt{4} + \sqrt{4}$

$33 = 4! + \frac{\sqrt{4} + \sqrt{4}}{.4}$

$34 = 44 - 4/{\cdot}4$

$35 = 44 - 4/\dot{4}$

$36 = 44 - 4 - 4$

$37 = 4! + 4 + \frac{4}{.\dot{4}}$

$38 = 44 - 4 - \sqrt{4}$

$39 = 4! \times \sqrt{4} - 4/\dot{4}$

$40 = 44 - \sqrt{4} - \sqrt{4}$

$41 = 44 - \sqrt{\frac{4}{\dot{4}}}$

$42 = 44 + \sqrt{4} - 4$

$43 = 44 - \frac{4}{4}$

$44 = 44 + 4 - 4$

$45 = 44 + 4/4$

$46 = 44 + 4 - \sqrt{4}$

$47 = 44 + \sqrt{\frac{4}{.\dot{4}}}$

$48 = 44 + \sqrt{4} + \sqrt{4}$

$49 = 4!\sqrt{4} + 4/4$

$50 = 44 + 4 + \sqrt{4}$

$51 = \frac{4!}{.4} - \sqrt{\frac{4}{4}}$

$52 = 44 + 4 + 4$

$53 = 44 + 4/\dot{4}$

$54 = 4!/\dot{4} + 4 - 4$

$55 = \frac{4!}{.\dot{4}} + 4/4$

$56 = 4!/.\dot{4} + 4 - \sqrt{4}$

$57 = \frac{4!}{.\dot{4}} + \sqrt{4/4}$

$58 = 4!/.4 + \sqrt{4} + \sqrt{4}$

$59 = 4!/{\cdot}4 - 4/4$

$60 = 4!/{\cdot}4 + 4 - 4$

$61 = 4!/4 + 4/4$

$62 = 4!/{\cdot}4 + 4 - \sqrt{4}$

$63 = 4!/{\cdot}4 + \sqrt{\frac{4}{\dot{4}}}$

$64 = 4!/{\cdot}4 + \sqrt{4} + \sqrt{4}$

$65 = \frac{4! + 4}{4} + \sqrt{4}$

$66 = 4!/4 + 4 + \sqrt{4}$

$67 = \frac{4! + 4}{4} + 4$

$68 = 4!/4 + 4 + 4$

$69 = 4!/4 + 4/\dot{4}$

$70 = \frac{4! + \sqrt{4} + \sqrt{4}}{4}$

$71 = \frac{4! + 4 + 4}{.4}$

$72 = \frac{4! + 4}{4} + \sqrt{4}$

$73 = \frac{4! \times \sqrt{4} + \sqrt{4}}{\sqrt{.4}}$

$74 = \frac{4! + 4}{.4} + 4$

$75 = 44/4 - 4!$

$76 = 4!/.\dot{4} + 4! - \sqrt{4}$

$77 = \frac{4! - .4}{.4} + 4!$

$78 = \frac{4! + 4! + 4}{\sqrt{.\dot{4}}}$

$79 = \frac{4! + 4}{.4} + 4!$

$80 = 4!/4 + 4! - 4$

$81 = \left(\frac{4}{.4}\right)\left(\frac{4}{4}\right)$

$82 = 4!/4 + 4! - \sqrt{4}$

$83 = \left(\frac{4}{4}\right)^{\sqrt{4}} + \sqrt{4}$

$84 = \sqrt{4}(44) - 4$

$85 = \left(\frac{4}{.4}\right)^{\sqrt{4}} + 4$

$86 = \sqrt{4}(44) - \sqrt{4}$

$87 = 4(4!) - \frac{4}{.4}$

$88 = 4(4!) - 4 - 4$

$89 = \frac{4! + \sqrt{4}}{.4} + 4!$

$90 = 4(4!) - 4 - \sqrt{4}$

$91 = 4(4!) - \frac{\sqrt{4}}{.4}$

$92 = 4(4!) - \sqrt{4} - \sqrt{4}$

$93 = 4(4!) - \sqrt{\frac{4}{.4}}$

$94 = 4(4!) - 4 + \sqrt{4}$

$95 = 4(4!) - 4/4$

$96 = 4(4!) + 4 - 4$

$97 = 4(4!) + 4/4$

$98 = 4(4!) + 4 - \sqrt{4}$

$99 = 4(4!) + \sqrt{\frac{4}{4}}$

$100 = 4(4!) + \sqrt{4} + \sqrt{4}$

SS 16: Show that the number

$a_0\, a_1\, a_2 \ldots\ldots \ldots\, a_n$

(where a's are digits) is divisible by a prime number p (except 2 or 5) if

$a_0\, 10^{n-1} + a_1\, 10^{n-1} + \ldots + a_{n-1} - ka_n$

is divisible by p where k is an integer such that $10k+1$ is divisible by p Use this result to find whether 390224 is divisible by 29.

Solution:

$$a_0\, 10^{n-1} + a_1\, 10^{n-1} + \ldots\ldots + a_n$$
$$= 10(a_0\, 10^{n-1} + a_1\, 10^{n-1} + \ldots + a_{n-1} - ka_n) + (10k+1)\, a_n$$

which is of the form

$$A = 10B + a_n C$$

If B and C are both divisible by p, then so is A If A and C are divisible by p and $p \neq 2$ or 5, then B must also be divisible by p.

Thus a necessary and sufficient condition for $a_0\, a_1 \ldots\ldots a_n$ to be divisible by p ($\neq 2$ or 5) is that

$a_0 10^{n-1} + a_1 10^{n-2} + \ldots\ldots + a_{n-1} - ka_n$

is divisible by p where k is an integer such that $10k+1$ is divisible by p.

If $p = 29$, we can choose $k = 26$ since 261 is divisible by 29. Thus 390224 is divisible by 29 if

$3 \times 10^4 + 9 \times 10^3 + 0 \times 10^2 + 2 \times 10 + 2 - 26 \times 4 = 39022 - 104 = 38918$ is divisible by 29.

This will be divisible by 29 if $3891 - 26 \times 8 = 3891 - 208 = 3683$ is divisible by 29.

This will be divisible by 29 if $368 - 26 \times 3 = 368 - 78 = 290$ is divisible by 29.

But this is true. Hence 390224 is divisible by 29.

For the application of this algorithm, we note that $10k+1 = p$ s.

By a proper choice of k, $10k+1$ can be made a multiple of any prime number p except 24 and5.

If p ends in 1, we choose $s=1$
If p ends in 3, we choose $s=7$
If p ends in 7, we choose $s=3$
If p ends in 9, we choose $s=9$
Thus for $p=7$, $s=3$, $k=2$
$p=23$, $s=7$, $k=16$
$p=31$, $s=1$, $k=3$
$p=59$, $s=9$, $k=53$

SS 17: You are given two sets of numbers

$$N=\{1, 2, 3, 4, 5, 6, 7, 8, 9, \ldots \ldots\}$$
$$E=\{1, 2, 4, 6, 8, 10, 12, \ldots\ldots\}$$

and the following definitions:

(i) A number x of a set S is a factor of y if there exists a number z of S such that $xz=y$

(ii) A number is a prime number if and only if its only factors are unity and number itself; other numbers are called composite

For the set E, prove the following statements

(a) The number of primes in E is infinite.

(b) There exists a formula for all primes in E.

(c) Every composite number cannot be factorized uniquely into a product of primes

Answer these questions also for the set

$$T=\{1, 3, 6, 9, 12, 15, \ldots\ldots \ldots\ldots\}$$

Solution:

(a) Every number of the form $4n+2$ is prime since $4n+2=2(2n+1)$ and $2n+1$ is not a member of E
Thus the number of prime numbers in E is infinite

(b) The formula $4n+2$ gives only primes and gives all primes, except possible 2.

(c) $36=2\times18=6\times6$
$60=2\times30=6\times10$

Thus every composite number cannot be factorized uniquely into a product of primes

For the set T, we have similar results.

(a) Consider numbers $3(3n-1)$, $3(3n+1)$. These are all members of T. They are all primes.

(b) We have already got a formula for all primes viz. $3(3n\pm1)$

(c) $36=3\times12=6\times6$

Thus unique factorization theorem does not hold.

SS 18: Assume that a club of students is organised into committees in such a way that each of the following statements is true:

(i) there are at least two students in the club,

(ii) every committee is a collection of one or two students,

(iii) for each pair of students, there is exactly one committee in which they serve;

(iv) no single committee is composed of all the students in the club;

(v) given any committee and any student not in that committee, there exists exactly one committee in which the student serves which has no student of the first committee as its member.

Prove each of the following statements in the following sequence, justifying each step of your proof by appealing to one or more of the five postulates or to an earlier statement of the sequence.

(a) every student serves at least in two committees;

(b) every committee has at least two members;

(c) there are at least four students in the club;

(d) there are at least six committees in the club

Solution: To be sent later.

SS 19 Let

$$K=(x_1-x_2)^2+(x_1-x_3)^2+\dots+(x_1-x_{2m})^2+(x_2-x_3)^2+\dots+(x_2-x_{2m})^2+\dots+(x_{2m-1}-x_{2m})^2$$

$$=\sum_{\substack{i,j=1\\ i<j}}^{2m}(x_i-x_j)^2$$

Find the maximum value of K if it is known that each x_i ($i=1, 2, \dots, 2m$) has the value 0 or 1.

Solution:

Obviously $K=\frac{1}{2}\sum_{j=1}^{2m}\sum_{i=1}^{2m}(x_i-x_j)^2$

Now $(x_i-x_j)^2 = 0$ if x_i and x_j are both 0 and 1
$= 1$ if one of these is 1 and the other is 0.

The values should be as different as possible.

The maximum value is attained when m of the values are chosen as 0 and m are chosen as 1 and these can be any m.

Let $x_1=1, x_2=1, \dots, x_m=1, x_{m+1}=0, \dots, x_{2m}=0$

then $(K)_{max} = m+m+m+\dots+m=m^2$

Alternatively

$$2K=\sum_{j=1}^{2m}\sum_{i=1}^{2m}(x_i-x_j)^2=\sum_{k=1}^{2m}\sum_{i=1}^{2m}(x_i-\bar{x}+\bar{x}-x_j)^2$$

where $\bar{x}=\frac{1}{2m}\sum_{i=1}^{2m}x_i$

$$2K=2m\sum_{i=1}^{m}(x_i-\bar{x})^2+2m\sum_{j=1}^{2m}(x_j-\bar{x})^2$$

$$=4m\sum_{i=1}^{2m}(x_i-\bar{x})^2$$

$$=4m\sum_{i=1}^{2m}x_i^2-2mx^2$$

Suppose 'n' of the x's are 1 and the remaining 2m—n are O, then

$$K=2mn-2m\left(\frac{n}{2m}\right)^2=2mn\left(1-\frac{n}{2m}\right)$$

$=2mn-n^2$

K is maximum when $n=m$ and

$K_{max}=2m^2-m^2-m^2$

SS 20

(a) Two numbers a and b are such that a is smaller and b is greater than 1 If S is the sum of a and b, and P is their product, prove that S and P differ by more than 1.

(b) Hence show that if the product of two positive numbers is 1, their sum cannot be less than 2.

(c) Using this result, or otherwise, prove that amongst right angled triangles isosceles triangle has the shortest hypotenuse.

Solution :

(a) Let $a=1-x$, $b=1+y$; x and y are positive.
$S-P=a+b-ab$
$=(2+y-x)-(1+y-x-xy)$
$=1+xy>1.$

(b) If both numbers are 1, their sum is 2. If one number is less than 1, then the other has to be greater than 1 because the product of the numbers is 1 Applying (a) we find $S>P+1$ or $S>2$ Thus in both cases $S\geqslant 2$.

(c) The area of the right angled isoscles triangle with base and height equal to k is $1/2k^2$.

Let $\sqrt{a}.k$ and $\sqrt{b}.k$ the base and height of a second right angled triangle of the same area, then $ab=1$. Applying the result of (b) the minimum value of the square on the hypotenuse (equal to $(a+b)\ k^2$) is $2k^2$, attained only when $a=b=1$.

Alternatively

(c) Let x and y be the two sides, then $1/2\,xy=$ const.

$x^2+y^2=(x-y)^2+2xy=(x-y)^2+4A$, so that x^2+y^2 is minimum when $x=y$.

SCHOOL SCIENCE

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In This Issue

Shri Baleshwar Prasad, Indian Ambassador in Burma handing over NCERT materials to Dr. Nyi Nyi, Deputy Education Minister of Burma.

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The New Philosophy of Biology Teaching

T. S SADASIVAN

Convenor
NCERT Study Groups in Biology, University of Madras, Madras

ONE of the major developments that has taken place in the field of education after the Second World War is the general acceptance of the need for a change in the system as well as philosophy of science education. There are two reasons for this. The first is that the phenomenal scientific and technological developments during the war have unfolded the realisation that economic growth and well being of a country can be achieved in the shortest possible time through the agency of science and technology. The second is that a quick improvement in the standard of science and technology is not possible without changing the older system of science education.

The importance of improving science and science education in our country at present cannot be more succinctly expressed than in the following words of Dr. D.S. Kothari ·

"The prosperity and strength of a country these days are directly dependent on the level of scientific and technical knowledge cultivated in the country and on its capacity to make use of that knowledge to serve practical ends Let us note in passing that in the contemporary industrial and political climate, it is not too difficult for a newly developing country to build (with the assistance of industrially advanced countries) new fertilizer factories, steel plants and so on, and these take only a couple of years or so to install. But to manage and run the plants efficiently and to maintain them properly, it requires a large number of competent technical men. It takes several years to train such men, and it is no easy task by any means. It demands a massive and reasonably sound educational system in the country A very important part of the system and specially so in relation to industrial development, is that of secondry education ...."

From the above words it should be clear that science education must not only aim at transmitting traditional values and knowledge from one generation to the next, but also at the building up of a base of responsible citizens and trained manpower that would serve as a ready reserve of personnel needed in order to institute suitable programmes for developing the economy of the country.

Biology as an Integrated Subject

From man's point of view, biology may be considered as the most fundamental and important of all sciences. Since the primary aim of science is the survival and welfare of man, there can be nothing more fascinating to him than a scientific understanding of the living organisms of which he himself is the most exalted. However, the study as

well as the teaching of the science of living organisms was compartmentalized into botany and zoology for a long time and the two disciplines developed almost independently of each other until recently. This was because the early men with their limited equipments could not discern much in common between the two basic sciences except some of the principal attributes of life. Each discipline developed its sub-branches in its own way without paying much need to what was happening in the corresponding branches of the other. The only notable exception to this was the cell theory which encompassed all living organisms.

The insight into the life processes gained in the past two decades has made it increasingly clear that there is much more that is common between plants and animals than what was realised earlier. Recent work on cell physiology with the newer tools of biochemistry, biophysics and biometrics has, particularly focussed our attention on the basic common denominations in the field of genetics, cytology, evolution, physiology and cell structure. Therefore, botany and zoology may now be considered to have been merged into biology in these areas, and as a result the old practice of teaching about plants and animals has given way to a common treatment in most countries of the world.

In the British and North American schools a composite biology course has been instituted for the last 10 to 15 years and many universities too have recently begun to offer biology courses at the B. Sc. and M. Sc. levels. Even at the research level many well known laboratories in the U.S.A. and the U.K. have a common unit for investigation on both plants and animals.

There is, therefore, need to do away with the practice of teaching botany and zoology as independent disciplines and instead teach biology as an integrated course at the school level. For many students the school biology course would be the only one which they will ever attend in their school career. Hence it is all the more necessary to give them a right perspective of the subject as it stands today. Also for those who wish to pursue higher studies in biology, introduction of the subject in the correct perspective at a young impressionable age, would go a long way in making them successful biologists.

Advances in Biology in the Present Century

Biologists of the previous centuries concerned themselves mainly with the external and internal morphology of plants and animals. The present century started with the rediscovery of Mendel's Laws of Inheritance The problem of inheritance baffled the earlier biologists who were approaching it for a long time mainly from the point of view of morphology. The introduction of mathematical (to be more precise statistical) methods by Mendel was the first great departure from conventional morphology. That biology obeyed the language of numbers infused new interest especially in the field of genetics and as a result introduced precise thinking in the study of problems of evolution

The firm establishment of the mechanism of inheritance was followed by the discovery of inducing mutations in plants and animals and the pin-pointing of genes responsible for the expression of particular characters. Electron microscopy, ultracentrifugation, spectrophotometry and other biophysical techniques followed in quick succession and helped to unravel the intricate machinery of the cell—the basic unit of life. These studies have now gone as far as the isolation and analysis of the sub-

stance of life, the DNA, and the deciphering of a universal genetic code. The great importance of enzymes in biological processes has been realized and their study which was a minor discipline four or five decades ago has developed into a vast field of research. Indeed, many enzymes have been crystallized and characterized. The knowledge of vitamins, harmones and antibiotics has increased enormously. The mechanism of vital physiological processes such as photosynthesis, respiration, nerve action, muscle action and brain functioning have been understood by recent researches. Finally may be added the development of disciplines like virology, radiation and space biology, and attempts to synthesize life itself.

The emphasis in biology has thus largely shifted from a descriptive and morphological treatment to the functional aspects. It is needless to say that we cannot any more continue to train our students in the 19th century biology as is being done in most of our schools and colleges, if they are to fit into the future patterns of employment anywhere in the scientific world.

Biology Books

Many of the existing biology textbooks in India are as much as fifty years behind current biological thought. The knowledge acquired in the present century does not find a place in them. Incorporation of latest ideas in school books is sometimes objected to on the ground that the recent aspects of biology involving biophysical and biochemical knowledge are too complicated to be understood by the school student. As a matter of fact, most of the teachers have not been exposed to these newer concepts and consequently there is resistance from that quarter also for any major change and modernization in our curricular pattern. This, however, does not seem to be correct.

Recent studies on the learning potential of young students have demonstrated that the seemingly difficult subjects can be effectively taught by suitably altering the method of presentation and approach, and with the aid of adequate demonstrations by the teacher and actual experimentation by the student. For example, a subject like digestion of starch by an enzyme could be explained easily with the help of proper experiments and would delight and enthuse the student more than mere sketching the shapes of flowers or animals or their internal parts. Furthermore, an experimentally oriented enquiry approach would go a long way in dispelling from the student's mind the impression that biology is nothing more than cutting earthworms and drying up plant twigs or just naming living organisms in unfamiliar language.

Another surprising fact of the school biology course in our country is that it teaches very little of human biology. As a result, students who study in detail the structure of plant parts like roots, stems and leaves and the smallest bones of frog, remain rather ignorant of the structure and functioning of their own body. It is the privilege of only those who study the medical course to know in detail about the human body.

Levels of Biological Organisation

Another conspicuous way in which biological knowledge has been reorganised recently is the relative shift in emphasis given to different levels of biological organisation. Biology began with emphasis on the whole organism because the early biologists who lacked tools and techniques could make observations only on the appearance and behaviour of the whole organism. With the development of tools, techniques and experience the study of the gross ana-

tomy of the parts of organisms began and the emphasis shifted to the tissues and organs.

From this centering on organs and tissues, biology has now developed phenomenally in a number of directions. In one important direction it has penetrated first to the cellular level and more recently to the molecular. In another direction the old emphasis on the behaviour of organism has revived. This fascinating subject is collectively called behavioural physiology. We are obtaining new knowledge of how the organism learns and how it develops behaviour patterns without learning. We are getting new insight into such processes as courting, mating, resting, self-defence etc. Beyond the organism we are tackling the growth and decline of populations especially through the tool of statistical genetics. Ecological studies on communities of diverse organisms, formations and biomes are rapidly widening the horizons of biology towards an understanding of the ultimate level of biological organisation—the world biome as a whole.

Recent Trends in Curriculum Development

In spite of the rapid advance of biology on all the different levels of organisation, textbooks in India continued to place the major emphasis on the individual and the organs alone as was naturally done in the last century and the beginning of the present century A realisation of this from an analysis of widely used textbooks in the U.S A. along with a need for the enquiry approach led to the formation of the Biological Sciences Curriculum Study in the United States. The result of this was the preparation of three versions of school biology with varying emphasis on different levels of organisation in each version The blue version for example lays more emphasis on the molecular level, the yellow on organism level and the green on society level. But none of them ignores any of the seven levels of organisation and attempt to present much of the recent advances in each level in an experimental and enquiry oriented approach.

The Nuffield curriculum of the U.K. which started after the B.S C S. has attempted to present an enquiry approach in its own way. These two curricula have kindled the thinking of almost all the countries of the world and many of them straight-away launched into preparing adaptations of one of these to suit the standard of education and biological material existing in their countries.

Biology, more than any other branch of science, is subject to considerable variations in regard to the availability of specimens and the predominance of certain groups of organisms from region to region. Therefore, a simple adaptation of any version that has been prepared primarily for one country cannot prove to be very satisfactory for another especially if the two belong to different geographical regions or different climatic zones in which case the biological variations are bound to be great. Hence it would be in the fitness of things for each country to prepare a biology curriculum of its own with the help of men who have a first-hand knowledge of the existing conditions and up-to-date knowledge of the advancing frontiers of biology.

Establishment of Study Groups

It is a surprising fact that till recently, the university men had kept themselves in the background in the formulation of school curricular materials in India. This was perhaps because of the old idea that school education is more concerned with padagogy than with the content and subject matter. Hence only those who had the requisite padagogical training were considered fit enough to draw a school curricular pro-

gramme. The result of this was that the experienced pedagogists who had lost contact with university education for many years continued to repeat outmoded curricula. Not only did the curricula thus become obsolete, but those who were teaching such curricula were left behind and they were no longer in the swim of world currents in science teaching.

The Report of the Education Commission focussed our attention to the appalling low standard of science and its steady decline in India. As a consequence, the Government of India took the important measure of establishing under the auspices of the University Grants Commission and the National Council of Educational Research and Training, a number of Study Groups in the subjects of biology, physics, chemistry and mathematics under the leadership of university professors supported by highly qualified men of science. This provided the opportunity for the first time in our country for university men to become directly involved in reforming the school curriculum.

In biology, four study groups started functioning from 1967 in the universities of Madras, Osmania, Calcutta and Punjab under the chairmanship of Prof. T.S. Sadasivan of University of Madras. In these study groups, for the first time in our country more than twenty university men specializing in the various disciplines of biology have come together and are working as a coordinated unit

Work of the Biology Study Groups

The first task of the biology study groups was to evolve a new curriculum for the school stage and write experimental versions of student's texts and teacher's guides for try-out in schools Accordingly, after considerable discussion among themselves and dialogues with visiting foreign experts in a series of workshops held from time to time at various centres, the study groups have evolved a tentative curriculum for the whole of the school stage

The aims and objectives that guided the study groups in framing the curriculum are the following:

1. The student should be encouraged to develop a curiosity and a spirit of inquiry about the world we live in and should have an intelligent understanding of the various biological phenomena.
2. Pupil's powers of observation should be developed in a planned way.
3 A desire for experimentation to understand basic principles behind accepted facts with emphasis on controlled experiments at every stage, should be inculcated
4. The principal laws, theories and processes governing life processes should be discussed.
5 A scientific attitude that would kindle in pupils a spark to become inventors, should be inculcated.

Other factors that were borne in mind were·

a. Biology should be something more than a mere description of living organisms. It should be a penetrating analysis of what makes something alive
b. Recent advances in biology should be reflected.
c Empirical first-hand experience on the part of the pupils are more important than course contents.
d. The development of the subject matter and the method of presentation should give much scope for

practical work which must include outdoor activities.

e. Practical work suggested at the middle school stage should include such activities as may promote the direct study of the local flora and fauna.

f. Theoretical teaching of biology should be preceded by a demonstration by the teacher and later on followed by experimentation by the pupils themselves.

g. The curriculum should be equally suited to the large majority of the pupils that may discontinue and seek a job at the end of the secondary level, and to those who would continue their studies further in the college.

h. The surrender value of biology which the pupil gains when he leaves the secondary school should be sufficient to make him a science-oriented, self-reliant and useful citizen fit to live in a scientific and technological world.

In regard to the overall design of the school curriculum of biology groups, the six year secondary school course has been divided into two stages: the first stage extends to the first three years and the second stage to the next three years. The first stage presents an overall picture of the essentials of modern biology at an introductory level. The second stage pushes it forward to a higher level by incorporating some of the latest ideas in the areas in which biology is advancing rapidly at the present time.

Experimental Editions of the First Stage

The work of preparing experimental versions of students' texts and teachers' guides for the first stage of 3 years was completed at the beginning of 1968. Printing of the experimental editions of books I to III and guides I to III was over in June 1968. The following is a very brief summary of the contents of the three texts:

The first book begins with the opening chapter on "Finding Out About Plants" in which a general summary of the plant world is followed by a detailed treatment of the external structure and functioning of the angiosperms. Since angiosperms are large plants ordinarily seen and have colourful flowers and variations which would interest the young students, these plants have been considered as the proper material for introducing biology The lower groups of plants have been avoided as they are comparatively insignificant and would require the help of a microscope for proper understanding. In fact, the use of a microscope has been avoided throughout the first year as the students would be too young to comprehend a magnified image under the microscope Furthermore, it would be a long time before we can hope to provide the first year pupils with microscopes.

The second chapter deals with the habits and habitats of animals.

Having been introduced to larger plants and animals the students are then taken in the third chapter to the scientific method of naming and classifying organisms. The first question a child asks when he or she sees a new object is what its name is. There can be, therefore, no doubt that names are of primary interest to the child and that the child becomes aware, even before the age of ten, of the importance of names and terms for communication and information The chapter speaks briefly about common and scientific names of organisms. Then follows the fact that differences between organisms is the basis for distinguishing organisms and hence for naming them also. The method of arranging character differences in

the form of a key to facilitate easy identification is given next. The chapter closes with a brief account of the chief groups of plants and animals. Latin names and technical terms have been kept at a minimum in presenting this most difficult but very essential concept to the young students.

Although the first three chapters introduce the students to a sufficient number of experiments and practicals, the emphasis in them is on the morphological and observational aspects of biology which is a conventional way of introducing a child to the things around him. Should this approach not find favour among teachers, the framers of the curriculum have an open mind in this and will suitably modify these introductory chapters based on the feed back of try-outs.

The fourth chapter introduces the idea of experimentation and explains how observations lead to hypotheses and then to experimentation. The use of "controls" in experiments is emphasised. How data are collected and analysed and final conclusions reached are illustrated by means of two experiments—one with a plant and the other with an animal.

The final chapter in Book I deals with the spread of living things. This is an aspect of biology that illustrates morphology in action, in other words, about the dispersal of organisms in space and the structural basis of such dispersal

Book II introduces the microscope in the first chapter. An elementary concept of cell as the basic unit of life and cell division are presented in the two subsequent chapters. For an intelligent and proper understanding of many aspects of living organisms it should be conceded that an elementary knowledge of cell structure and cell division is needed. This is the reason for introducing the microscope and study of cells at the beginning of the second year, inspite of the fact that providing adequate number of microscopes at this level may prove to be difficult at present.

The fourth chapter of Book II deals with the origin and continuity of life. The controversy between abiogenesis and biogenesis is presented in a historical perspective followed by an elementary account of fossils and life in the past.

The fifth chapter is essentially experimental After giving an account of the physicochemical properties of protoplasm, important life processes such as nutrition, respiration, transport, water economy and excretion, coordination and locomotion are presented. The approach is somewhat biochemical but at an elementary level. It is to be hoped that this would be within the comprehension of the children of the age group to which it is addressed

Two more physiological aspects—growth and development—are dealt with in the two subsequent chapters. Under growth, the distinction between growth and differentiation, rate of growth, pattern of growth and factors influencing growth are presented. Developmental morphology of frog, toad and chick with details of the method of handling eggs, and the developmental morphology of a flowering plant are the subjects dealt with under development.

The final chapter of Book II is an ecological one concerned with interdependence among the living. Food habits, food chains, biotic communities and biomes, and wild life conservation are the ecological concepts that are dealt with in this. This seems particularly important in a tropical country like India where every landscape is an ecologist's paradise.

The whole of Book III is devoted to aspects that immediately concern man in his day to day life. The first chapter describes man as a biological machine with the struc-

ture and working of the various systems of his body.

The second chapter deals with a very essential aspect in the life of man—the role of microorganisms in health and disease. The third chapter covers personal hygiene which is intimately connected with man as it is his natural environment that he is most concerned with.

The last chapter of the first stage deals with agriculture, its problems and progress especially with reference to Indian conditions. Agriculture, the most important and ancient application of biology to human welfare is still the primary industry of mankind more especially in India. Hence it appears to be a fitting final chapter rounding off the first stage of school biology.

Books IV to VI represent the second stage in the biology curricular development programme and are expected to go to press by January 1970. The curriculum of these is briefly summarised below.

The first book of the second stage (Book IV) is entirely devoted to a treatment of ecology in considerable detail under the headings—life in water, life on land, forest life, web of life, cycles of matter, and conservation of biological and natural resources.

Book V is designed to introduce the dynamic aspects of living systems taking the cells or tissues as basic structures The book is loaded with concepts of modern thought, experimental needs and current endeavours correlated with a historic background.

Book VI is a culmination of biological studies prior to the close of school career. The wider theoretical questions of biology involving heredity, evolution and man's relation to nature are covered in this.

It seems necessary to state here that the incorporation of latest concepts in biology and the introduction of an enquiry approach is bound to make the curriculum rather difficult to be taught by teachers who have not been exposed to summer institutes in recent years This may stand in the way of implementing this programme on a nationwide basis but cannot be taken as a deterrent. The challenge has to be accepted and every effort made to meaningfully implement these new curricular materials in as short a time as possible.

Teacher's Guides

The teacher's guide is designed to help the teachers to get over difficulties which they are likely to encounter in effectively covering the texts and setting up meaningful practicals The guides give details of lesson-wise break-up of each chapter, materials, equipments and advance preparations needed for each lesson, method of presenting the lesson, instructions for conducting demonstrations and practicals, answers to open ended questions in the texts, and enrichment material on aspects that are merely touched upon in the text.

Programme of Try-out

The B.S C.S. texts as well as the Nuffield 'O' level, 'A' series have been finalised after considerable try-outs of the materials in the U S.A. and U.K in classrooms by trained teachers. This is the right thing to do and there can be no better alternative for a correct evaluation of the suitability of the material for school children This would be the pattern in this country where the study group materials could be tried out in a limited number of schools throughout the country and the reaction and comprehension of the students evaluated by means of suitably designed tests On the basis of the data collected from the tests the experimental versions may have to be modified

and the final version prepared.

There is little argument in that the text has to reach the pupils only through the teachers. Teachers who have been accustomed to the old texts and teaching methods may find it embarassingly difficult to adapt themselves to the new philosophy especially in the rural schools

In order to find out whether the new texts are likely to meet with teacher resistance, a sample survey has been conducted Sets of text and teacher's guide of the first stage were sent to teachers both rural and urban chiefly in the Tamil Nadu and to eminent educational authorities and institutions throughout India. They were asked to send their comments in a comprehensive printed questionnaire that was attached at the end of each text and teacher's guide as tear off sheets. Sets were also given to teachers who participated in two Nuffield and one B.S.C.S Summer Institutes at Madras.

The result of this survey has been most encouraging. Out of a total of 173 urban and rural schools in and around Madras to whom the texts and guides were sent, replies have been received from 70. The replies were analysed critically and statistically, in a question-wise and chapter-wise manner.

Almost all the teachers and authorities have welcomed the texts as a worthy improvement over the existing ones, both in content and method of approach. None of them mentioned that the texts would go beyond the comprehension of the students. Some have, however, stated that certain portions may prove a bit difficult. The reaction of the rural schools has not been found to differ appreciably from that of the urban schools.

With regard to the ability of the teachers to present the material, the teacher's guides have been welcomed as a very valuable help However, many have stated, that with the help of the guides alone, it would not be possible for even a graduate trained teacher to teach the texts in a satisfactory manner, unless he is specially oriented and trained for this purpose. It is true that the texts and guides have been designed for being taught by graduate trained teachers. Nevertheless, it would be a long time before this ideal situation is realised in our schools. In fact, many have stated in their replies that at present secondary grade teachers teach at the middle school stage in almost all the schools and as such, they recommend special training and orientation if the texts are to be presented in a satisfactory manner to the pupils.

Summer Institutes

All the summer institutes have till now been based on the B S.C.S. or Nuffield materials and none on the materials prepared by the Biology Study Groups The general enrichment provided by the institutes would certainly help a teacher to teach any text that incorporates latest advances. Nevertheless, a training and orientation based on the study group texts and guides would be the ideal one for teaching them successfully. Since the number of school teachers who have already been exposed to the summer institutes are a few and many more are to be trained, it would appear to base the forthcoming institutes on the basis of the study group texts.

It may not, however, be possible to orient all the teachers needed for a large scale try-out of the study group texts through summer institutes alone Special short-term orientation courses would have to be conducted preferably by the study group in order to orient a sufficient number of teachers in the first instance.

Limited Try-outs

In addition to the survey of teacher reaction, two teachers attached to the Madras study group presented Book I in the actual classroom in three schools allotted for the purpose by the Director of School Education, Tamil Nadu. Although the text was taught as an additional material and did not form part of the regular course, the students have shown great enthusiasm and real interest in learning it. No portion of the text was found to be beyond their comprehension.

Evaluation

In consonance with the new approach of the texts, suitably designed evaluation tests are very necessary for a correct evaluation. The old method of memory based examinations must be changed Evaluation techniques have now been developed for testing the whole intellectual personality of pupils without giving undue weight to memorising ability alone However, the construction of a test paper to evaluate the knowledge, understanding, technique, skill and application aspects of a student in a balanced manner is not an easy job. This is as much a specialist's job and as much time consuming as that of drawing up a curriculum and preparing texts and teacher's guides. The school teachers, even after adequate training on the teaching of the texts cannot be expected to do the testing all by themselves.

It is an accepted fact that the best personnel for constructing proper tests are the authors who write the texts. It is they who know more than anybody, the aims and objectives of the text and what understanding and abilities the students are expected to acquire from a chapter or lesson. Therefore, the next immediate task of the study groups would have to be the preparation of model evaluation tests based on the experimental edition for use by the teachers

Another aspect of the try-out is the time scale involved. All the experimental texts cannot be tried out simultaneously in classes 5 to 7 or 8 to 10. The curriculum has essentially a linear development not only from year to year of each stage, but also from the first stage to the second A student who has not been exposed to the first book would not be able to assimilate the second. A satisfactory comprehension of any text presupposes the study of all the previous texts. Hence the try-out programme is bound to be drawn out for six years if it is to be done in the correct manner. If the preparation of the final version can be done quickly and introduced in the second year after the try-out, then the introduction of the revised and finalised tests could be completed in eight years This would seem a long time but such a time schedule has been experienced by the B S C.S. and the Nuffield people also

The biology study groups have hitherto been functioning independently of the educational machinery of the States on whom the ultimate responsibility of carrying the message of the New Biology series rests This is understandable because the preparation of a revised curriculum and texts incorporating modern trends for the whole of the country need not directly involve the State authorities However, from the stage of commencement of the try-out of these materials in the State controlled schools, it is essential to establish a close and healthy coordination between the study groups and the State machinery of education. If this liaison can be successfully established, subsequent preparation of the final versions would become a reality in a much shorter time than at present feared it may take.

Background Reading Material

It would seem an impossible task to even

attempt to present the vast knowledge content of any subject through textbooks alone. Textbooks can at best serve only to indicate the broad areas of knowledge with a limited number of examples. A comprehensive knowledge in any area of a subject can be acquired only by reading additional books. It becomes inescapable that school students be provided with opportunities for reading much supplementary material. Indeed, the Nuffield programme has brought out a number of booklets as background reading material for the school students.

In our country, there are practically no books even on essential science subjects written in a popular style and comprehensible to the school students. This is undoubtedly a drawback To rectify this situation, the Biology Study Group has envisaged a scheme of bringing out booklets on various topics of interest in biology. Each booklet is designed to be about 50 pages, adequately illustrated and written in a nontechnical style so that it is comprehensible not only to the school students but to the general public as well. At present 19 basic topics in biology have been chosen for this presentation and eminent biologists who are specialists in the concerned topics have agreed to write them. Three of these are already in the press and it is hoped that the others would be completed soon.

The Future

Even after the introduction of the finalised version in the schools, the work of improving such biology curriculum cannot be claimed to be complete Biological knowledge continues to advance at a rapid rate. In the course of nearly one decade needed to introduce the currently developed materials, many of the concepts may have undergone changes The B.S.C.S. has, within six years of introducing its first finalised versions, modified all of them and brought out a second edition. Likewise the Nuffield people are working at improving their material. Indeed, the work of the study groups has to be a continuum This would call for the establishment of the study groups on a permanent basis. Permanency would ensure the needed uninterrupted vigil and improvement of school education Furthermore, any wide-spread introduction of improved curricula should be backed by a permanent organization to which the participating schools can at any time refer their difficulties and look forward to receiving proper guidance. Without this the schools cannot feel secure in their venture and boldly initiate improvement measures. It would not be wise and proper to leave the schools severely alone in a protracted programme, after providing them all possible help and facilities in the introductory phase, and expect them to look after themselves The success and achievement of any long range programme depends not merely on an effective initiation but on sustained assistance for many years ahead.

Summary

The groups have been established as a consequence of the imperative need to improve the school curriculum in line with that of the advanced countries. The first phase of the programme is the preparation of texts and teacher's guides incorporating modern concepts and an activity-based inquiry approach. This work is already complete for the first stage of the first three years of middle school education and the second stage for the high school is nearing completion The second and most immediate task is to try out these experimental materials in the actual classroom and evaluate their suitability from the point of view of the teachers and the students.

For this, the needed apparatus and kits have to be designed from indigenous and readily available materials so that they are inexpensive and can be mass-produced without sacrificing quality. Evaluation tests incorporating modern methods have to be designed. Sufficient number of school teachers have to be oriented for the try-out. In the programme of try-out a full scale collaboration of State educational machinery has to be established On the basis of the data collected from the try-out, the final versions are to be prepared After that, continued efforts are to be made to maintain the standard of school education at an up-to-date level This would involve vigilant and constant modernization of the curriculum in consonance with advances of biological science and production of background materials for enrichment of knowledge.

The Value of π

R. N Rai
Indian National Science Academy, New Delhi

IN many of our calculations we have to put a numerical value of π and we generally take it to be 22/7. We get so much used to this value of π that we begin to think that it is the exact value of π and prefer it to the more accurate value 3 1416 which was stated by the famous Indian mathematician Āryabhata in about 500 A.D Science students are sometimes required to determine the value of π by measuring accurately the circumference and diameter of a circular cylinder. This gives them a wrong impression that the value of π can be measured experimentally. The present article will show the development in the method of determining the value of π with greater and greater accuracy till today its value is known, with the help of computers, to several thousand places.

The earliest determination of the value of π was made by the Egyptians and the Babylonians. The Egyptians built the Great Pyramid in about 3800 B.C There are two remarkable things about this Pyramid One is the ratio of the base edge to the height. Although the disappearance of most of the casting stones due to various causes made the exact measurement difficult, the mean of a large number of very careful measurements carried over many years show that each side of the base was approximately 9120 inches and the vertical height 5804 inches. The ratio of these two quantities is very nearly 11/7 which is generally taken as an approximate value of $\pi/2$ The other remarkable point is that 9120 inches is very nearly equal to 1/8 of a minute of latitude on the surface of the earth

But the above ratio gives $\pi = 3\ 074$, the error in which amounted to about 0.07 The Egyptians guessed a much better value for π by about 1500 B.C They took the area of a circle to be equal to the square of 8/9 of the diameter. This would amount to taking $\pi = 4 \times (8/9)^2 = 3\ 1605$ The error in this value amounts to about 0 02.

In India a more accurate value of π was known earlier than any where else The Vedic priests needed for their yajñas vedikas (altars) of various shapes and sizes and they were interested in drawing a circle equal in area to a square. The earliest values of π have been calculated in the Śulva Sūtras which were composed about 800 B.C., although the problem of constructing a circle equal in area to a given square or constructing a square equal in area to a given circle are met with much earlier during the time of the Tattiriya Samhita and other Samhitas whose date may be placed about 1200 B.C. However, it is difficult to say if the method used during the time of the Samhitas is the same as that described in the Śulva Sūtras

The directions given by Baudhāyana in his Śulva Sūtra for constructing a circle equal in area to a square are the following.

"If you wish to circle a square, draw half its diagonal about the centre towards the east-

west line, then describe a circle together with the one-third of that which lies outside (the square)"

The same method has been taught also by Āpastamba and Kātyāyana. To make the meaning of the above aphorism clear, we will take a specific case. Let ABCD be a square with central point O. Join OA. With O as centre and OA as radius, draw a circle to cut the east-west line EW at E. Divide EM at P such that PM=EM/3. Then with centre O and radius OP describe a circle. The circle will be nearly equal in area to the given square ABCD.

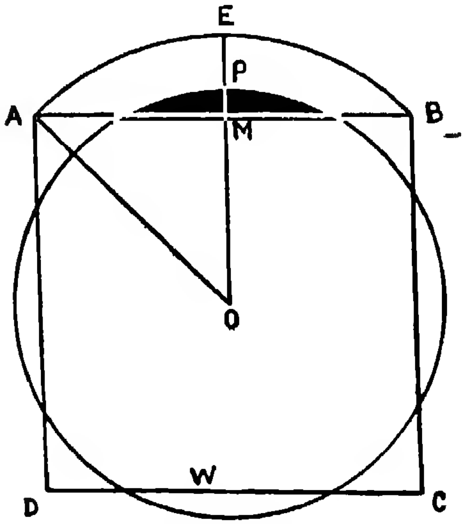

Fig 1

If a denotes a side of the given square, then $OA = a/\sqrt{2}$ and $ME = (\sqrt{2}-1)\frac{a}{2}$.

Hence,

$$r = \frac{a}{2} + \frac{a}{6}\left(\sqrt{2}-1\right) \text{ and } d = \frac{a}{3}(2+\sqrt{2}),$$

where d = diameter.

We may consider how they hit upon this value for the radius and the diameter. If the correct value of the diameter is given by the relation $D = ax$, it is easy to see that $x < \sqrt{2}$, as a circle with diameter $a\sqrt{2}$ lies wholly outside the square. On the other hand $x > 1$, as a circle with diameter equal to a lies wholly inside the square. Hence we have $1 < x < \sqrt{2}$. But even a superficial view will show that the difference between the inner circle and the square is not as great as that between the outer circle and the square. Hence giving a weightage of two to the inner value, we get the weighted mean as $x = \frac{2+\sqrt{2}}{3}$.

This gives

$$a^2 = \frac{\pi D^2}{4} = \frac{\pi}{4}a^2\left(\frac{2+\sqrt{2}}{3}\right)^2$$

$$\text{or } \frac{\sqrt{\pi}}{2} = \frac{3}{2+\sqrt{2}}.$$

Before we can proceed further, we have to see how they found the value of $\sqrt{2}$. It was easy to see that

$$\sqrt{2} < \frac{3}{2} \text{ as } 2 < \frac{9}{4} \text{ and } \sqrt{2} > \frac{4}{3} \text{ as}$$

$$2 > \frac{16}{9}.$$

$$\text{Hence, } \sqrt{2} \cong \frac{1}{2}\left(\frac{3}{2}+\frac{4}{3}\right) = 1+\frac{1}{3}+\frac{1}{2}\left(\frac{1}{2}-\frac{1}{3}\right) = 1+\frac{1}{3}+\frac{1}{3.4}.$$

Again $\left(\frac{3}{2}\right)^2 - 2 > 2 - \left(\frac{4}{3}\right)^2$. Hence it is easy to see that

$$\sqrt{2} < \left(1+\frac{1}{3}+\frac{1}{3\,4}\right) = \frac{17}{12}$$

$$\text{Now } 2 = \left[\left(\frac{17}{12}\right)^2 - \left(\frac{1}{12}\right)^2\right] = \left(\frac{17}{12}\right)^2\left[1-\left(\frac{1}{17}\right)^2\right]$$

Hence using the formula $\left(a^2+b^2 \right)^{\frac{1}{2}} = a + \frac{b^2}{2a}$, if $b << a$, we have $\sqrt{2} = \frac{17}{12}\left(1 - \frac{1}{17.34}\right) = 1 + \frac{1}{3} + \frac{1}{3.4} - \frac{1}{3\,4\,34}$

This is the value given both by Baudhāyana and Āpastamba, though both of them assert that the value is a little greater than $\sqrt{2}$ The difference between this value and the more correct value is 0 000002.

Substituting this value of $\sqrt{2}$ in the expression for π, we get

$$\frac{\sqrt{\pi}}{2} = \frac{3}{2+\sqrt{2}} = \frac{3}{2+\frac{577}{408}} = \frac{1224}{1393}$$

$$\text{Now } \frac{1224}{1393} < \frac{1224}{1392} = \frac{7}{8} + \frac{1}{8.29},$$

$$\text{and } \frac{1224}{1393} > \frac{1223}{1392} = \frac{7}{8} + \frac{1}{8.29} - \frac{1}{8.29.6}$$

Baudhāyana gives the value

$$\frac{\sqrt{\pi}}{2} = \frac{7}{8} + \frac{1}{8.29} - \frac{1}{8.29.6}\left(1 - \frac{1}{8}\right).$$

Thibault has explained how Baudhāyana arrived at this value which differs very slightly from $\frac{1224}{1393}$. But we need not go into it The value of π obtained from the above formula is 3.088.

Surya-Prajñapti, a Jain work of the fourth or fifth century B.C. proposed the value $\sqrt{10}$ for π. Reduced to decimal notation $\pi = 3\ 1622$.

In the third century B C. Archimedes showed, by inscribed and circumscribed polygons of 96 sides that

$$3\frac{10}{71} < \pi < 3\frac{10}{70}, \text{ i.e.}$$
$$3.141 < \pi < 3.143$$

This was a much better approximation than any one of the previous values. Later, it is said, Haron (100 A D) refined the method of Archimedes and showed that

$$\frac{35,312}{67,441} < \frac{\pi}{6} < \frac{36,647}{62,351}, \text{ i e}$$
$$3\ 141589 < \pi < 3.14160$$

But it is not known how he arrived at this result. Ptolemy (150 A D.) proposed the value $\frac{377}{120} = 3.1417$

The Indian Mathematician and astronomer Āryabhata (500 A.D.) said that π is nearly equal to 3.1416 In his case also we do not know how he arrived at this value. But he must have had some method of calculating the value of π since he states that this is only an approximate value But Indian mathematicians continued to use the approximate values $\sqrt{10}$ and $\frac{22}{7}$ for the sake of convenience in their calculations

There is an almost continuous record of Chinese efforts to obtain the value of π following the method proposed by Archimedes. Liu Hsin, a mathematician of the 1st century B.C. seems to have arrived at the value 3.154 but it is not known how he got this result. Chang Hang a second century Chinese mathematician proposed the value $\sqrt{10}$ which had been given by the Indians in the fourth or fifth century B.C. In the latter half of the third century, Liu Hui , by considering an inscribed polygon of 192 sides got a rough value of $157/50 = 3.14$ but he also showed that the value of π lies between $3.14\frac{64}{625}$ and $3.14\frac{169}{625}$. If we consider the value given by Āryabhata, it is $3.14\frac{100}{625}$

which lies between these two values. Whether Āryabhata obtained his value by a similar process or some other method, is not known. Liu Hui continued his process and considering a polygon of 3072 sides obtained the value 3.14159.

But the most important Chinese contribution was made in the latter half of the fifth century when Tsu Keng-Chih and his son Tsu Chhung-Chih showed that

$$\pi = \frac{355}{113} = 3.1415929203 \text{ which is correct}$$

upto the sixth decimal place They also showed that $3.1415926 < \pi < 3.1415727$ which was a great advance on the previous values.

It is not known how the Chinese arrived at the result $\pi = \frac{355}{113}$. But the Indian mathematician S. Ramanujan gave a method of drawing a length the square of which will be equal very nearly to the area of the circle From that length we can show that $\pi = \frac{355}{113}$. His method is as follows:

Let PQR be a circle with Centre O, of

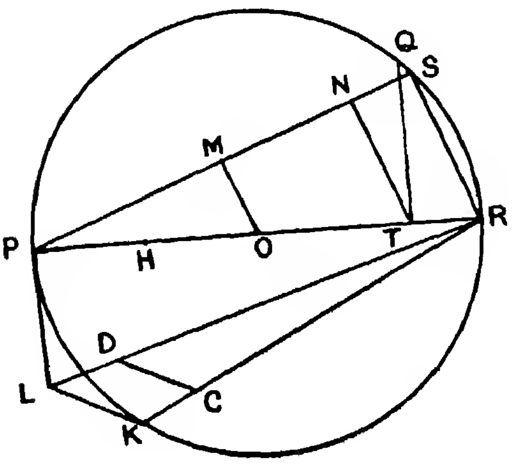

Fig. 2

which a diameter is PR Bisect PO at H and let T be the point of trisection of OR nearer R Draw TQ perpendicular to PR and place the chord RS = TQ. Join PS and draw OM and TN parallel to RS. Place a chord PK = PM and draw the tangent PL = MN Join RK, RL and KL. Cut off RC = RH Draw CD Parallel to KL meeting RL at D

Then square on RD will be equal to the circle approximately.

For $RS^2 = \frac{5}{36} d^2$,

where d is the diameter of the circle.

Therefore $PS^2 = \frac{31}{36} d^2$.

But PL and PK are equal to MN and PM respectively,

therefore $PK^2 = \frac{31}{144} d^2$, and

$$PL^2 = \frac{31}{324} d^2,$$

hence $RK^2 = PR^2 - PK^2 = \frac{113}{144} d^2$,

and $RL^2 = PR^2 + PL^2 = \frac{355}{324} d^2$.

$$\text{But } \frac{RK}{RL} = \frac{RC}{RD} = \frac{3}{2}\sqrt{\frac{113}{355}},$$

and $RC = \frac{3}{4} d$

$$\text{Therefore } RD = \frac{d}{2}\left(\sqrt{\frac{355}{113}}\right) = r\sqrt{\pi},$$

very nearly.

Another empirical formula derived by Ramanujan is the following·

Let AB be a diameter of a circle whose centre is O. Bisect the arc ACB at C and trisect AO at T. Join BC. and cutoff from it CM and MN equal to AT.

Join AM and AN and cut off from the latter AP = AM Through P draw PQ parallel to MN and meeting AM at Q.

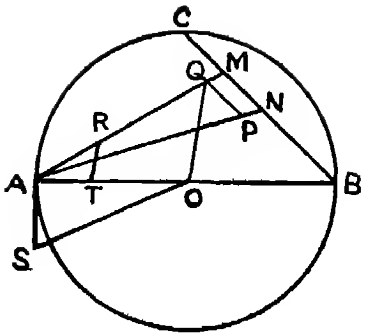

Fig 3

Join OQ and through T draw TR, parallel to OQ, and meeting AQ at R. Draw AS perpendicular to AO and equal to AR, and Join OS.

Then the mean proportional between OS and OB will be very nearly equal to a sixth of the circumference.

$$\frac{AQ}{AP}=\frac{AQ}{AM}=\frac{AM}{AN}.$$

Therefore $\quad AQ=\dfrac{AM^2}{AN}.$

Now $\quad AM^2=\left(\dfrac{d^2}{2}+\dfrac{d^2}{36}\right)=\dfrac{19d^2}{36},$

and $\quad AN=\left(\dfrac{d^2}{2}+\dfrac{d^2}{9}\right)^{\frac{1}{2}}=\sqrt{\dfrac{11}{18}}d.$

Therefore, $\quad AQ=\dfrac{19d^2}{36}\cdot\sqrt{\dfrac{18}{11}}\cdot\dfrac{1}{d}$

$$=\frac{19d}{6\sqrt{22}}$$

Now $\quad AS=AR=\dfrac{1}{3}AQ=\dfrac{19d}{18\sqrt{22}},$

and $\quad OS=(AS^2+OA^2)^{\frac{1}{2}}$

$$=\left(\frac{d^2}{4}+\frac{19^2d^2}{18^2 22}\right)^{\frac{1}{2}}=\frac{d}{18}\left(9^2+\frac{19^2}{22}\right)^{\frac{1}{2}}$$

Therefore the mean proportional between OB and OS is

$$(OB.OS)^{\frac{1}{2}}=\left\{\frac{d}{2}\cdot\frac{d}{18}\left(9^2+\frac{19^2}{22}\right)^{\frac{1}{2}}\right\}^{\frac{1}{2}}$$

$$=\frac{d}{6}\left(9^2+\frac{19^2}{22}\right)^{\frac{1}{4}}$$

therefoie $\quad \pi=\left(9^2+\dfrac{19^2}{22}\right)^{\frac{1}{4}},$

$$=3.141592653597943 \quad \ldots\ldots$$

The value of π ıs 3.141592653589743 . . . .

It will be obseıved that the second value is correct upto twelve sıgnıficant figures.

The next great advance was taken, many centuries later, by Hındu methematıcıans of South India and Muslim mathematıcıans of Central Asıa. About 1500 A.D the Kerala mathematıcıan Nılakantha Somasutvan commentıng on the verse in Aryabhatıya, giving the value of π, quotes an older mathematıcıan Mādhava, who flourished ın the fourteenth century and who has gıven the value of π as the ıatıo of two large numbers The numerator ıs 2827433388233 and the denomınator is 9×10^{11} Actually ıt is said that a value whıch approxımates more to the value of π is given by the ratıo of these two numbers. The value can be easıly shown to be 3.14159265359.

But the most ımportant poınt ıs that Nilakantha Somasutvan as well as the father of hıs teacher, Parmeshwar, who also had commented on Aryabhatıya in the earlier part of the fifteenth century assert that π ıs incommensurable, though they do not state the proof It ıs better to quote the exact words of Parmeshwara.

चतुरधिकं शतं यत्तदष्टगुण । सहस्राणां द्वाषष्टिश्च । एतदयुतद्वयविष्कम्भकस्य वृत्तस्यासन्न परिणाहः । ननु निश्शेष इत्यर्थः । ..परिधिव्यासयोरेकस्यैव हि निश्शेषता संभवति । इतरस्य सावयवता सभवत्येव ।

Translatıon; That which ıs obtaıned by addıng four to hundred and multıplying the sum by eıght (that is eight hundred and thirty-two) when added to sixty-two thousand gives approximately the cırçum-

ference of a circle of diameter twenty-thousand The meaning is that it is not exactly divisible Of the circumference and the diameter the commensurability of only one is possible Of the other only incommensurability is possible.

Nilakantha Somasutvan states the same concept much more elaborately. Says he·

कुत· पुनर्वास्तवी संख्यामुत्सृज्यासन्नैवेहोक्ता । उच्यते । तस्या वक्तुमशक्यात्। कुत.। येन मानेन मीयमानो व्यासो निरवयव· स्यात्, तेनैव मीयमान परिधि: पुन. सावयव स्यात् । येन च मीयमान: परिधिर्निरवयवस्तेनैव मीयमानो व्यासोऽपि सावयव एव, इत्येकेनैव मानेन मीयमानयोरुभयो. क्वाकपि न निखयवत्वं स्यात् । महान्तमध्वान गत्वाप्यल्पावयवत्वमेव लभ्यम् । निरवयवत्व तु क्वापि न लभ्यमिति भाव:। कुत: पुनरनयो: शक्यापवर्तनत्वेऽप्यनपवर्त्यैव महान्तौ राशी प्रतिपादितौ ।

Translation: Why then is it that discarding the exact value, only the approximate value has been stated here? This is the answer· because it is not possible to state it (the exact value) Why is it so? If the diameter is commensurable when measured with respect to a particular unit, then with-respect to the same unit the circumference can not be exactly measured; and if, with respect to any unit, the circumference is commensurable, then with respect to the same unit, the diameter can not be exactly measured That is to say, with respect to any unit of measurement both will not be (simultaneously) commensurable. The idea is that though by going a long way the non-commensurability can be made small, the absolute commensurability can never be attained. Then what is the use of proving again only the possibility of their commensurability and non-commensurability by large numbers?

In the year 1500, Nilakantha Somasutvan wrote a book *Tantra Sangraha* which contains formulae which can only be derived from the series.

$$\tan^{-1} t = t - \frac{t^3}{3} + \frac{t^5}{5} - \frac{t^7}{7} - \frac{t^9}{9} - \frac{t^{11}}{11} + \dots \dots \quad (1)$$

which was proved by Gregory much later in 1671 and is known after him. This shows that the series was known to the Indians. Most probably the above series was known to Mādhava, who was a teacher of Parmeshwara, because, without the knowledge of the above series and the rapidly converging series derivable from it, it is not possible to calculate the value of π upto twelve places. This series was either derived by Madhava himself or some mathematician earlier than Madhava

We give below some of the series which can be derived from equation (1) and are given in *Tantra Sangraha*. If we put

$$t = \frac{1}{\sqrt{3}}$$

in equation (1) we get

$$\frac{\pi}{6} = \frac{1}{\sqrt{3}} - \frac{1}{3.3\sqrt{3}} + \frac{1}{5.3^2\sqrt{3}} - \frac{1}{7\,3^3\sqrt{3}} + \dots \dots \dots$$

which can be rewritten as

$$\pi = \sqrt{12}\left(1 - \frac{1}{3\,3} + \frac{1}{5.3^2} - \frac{1}{7.3^3} + \dots\right) \dots \dots \quad (2)$$

This was derived by Abraham Sharp later in about 1717.

By putting t = 1 in equation (1), we get the equation

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} \quad \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \dots \dots \quad (3)$$

Grouping the terms of equation (3), we have

$$\frac{\pi}{4} = \left(1 - \frac{1}{3}\right) + \left(\frac{1}{5} - \frac{1}{7}\right) + \left(\frac{1}{9} - \frac{1}{11}\right)$$

and

$$\frac{\pi}{4}=1-\left(\frac{1}{3}-\frac{1}{5}\right)-\left(\frac{1}{7}-\frac{1}{9}\right)-\left(\frac{1}{11}-\frac{1}{13}\right)\ .\ \ldots$$

From the first of these regrouped equations, we deduce that

$$\frac{\pi}{8}=\frac{1}{2^2-1}+\frac{1}{6^2-1}+\frac{1}{10^2-1}+ \qquad \ldots (4)$$

and the second of the regrouped equations gives

$$\frac{4-\pi}{8}=\frac{1}{4^2-1}+\frac{1}{8^2-1}+\frac{1}{12^2-1}+ \qquad \ldots (5)$$

Substracting equation (5) from equation (4), we have

$$\frac{\pi-2}{4}=\frac{1}{2^2-1}-\frac{1}{4^2-1}+\frac{1}{6^2-1}-\frac{1}{8^2-1}+\frac{1}{10^2-1}-\frac{1}{12^2-1}+ \qquad \ldots (6)$$

Two others series given in *Tantra Sangraha* are a little more difficult to derive and they are simply stated here. They are

$$\frac{\pi-3}{4}=\frac{1}{3^3-3}-\frac{1}{5^3-5}+\frac{1}{7^3-7}-\frac{1}{9^3-9}+ \qquad \ldots . (7)$$

$$\frac{\pi}{16}=\frac{1}{1^5+4.1}-\frac{1}{3^5+4.3}+\frac{1}{5^5+4\ 5}-\frac{1}{7^5+4.7}+ \qquad \ldots . (8)$$

In addition, Tantra Sangraha gives three more series based on the series (3) and (6) in which an adhoc additional term has been putin which will give a good approximate value of π after a certain number of terms have been included The first one based on series (3) is

$$\frac{\pi}{4}\rightleftharpoons 1-\frac{1}{3}+\frac{1}{5}\ldots\pm\frac{1}{2}\mp\frac{(n+1)^2}{(n+1)^2+1} \quad (9)$$

It is then claimed that a better value will be obtained if the adhoc term is slightly different. The new series, also based on series (3), is

$$\frac{\pi}{4}\rightleftharpoons 1-\frac{1}{3}+\frac{1}{5}\ \ldots\pm\frac{1}{n}\mp\frac{\left(\frac{n+1}{4}\right)^2+1}{\left(\frac{n+1}{2}\right)\{(n+1)^2+4n+1\}} \qquad \ldots (10)$$

The next series is based on series (6) and is

$$\frac{\pi-2}{4}\rightleftharpoons\frac{1}{2^2-1}-\frac{1}{4^2-2}+\ldots\pm\frac{1}{n^2-1}\mp\left[\frac{1}{2\{(n+1)^2+2)\}}\right] \qquad \ldots . (11)$$

These are the earliest known analytical expressions for the value of π.

The values of π obtained by the first ten terms of the series (2), (3), (4), (5), (6), (7), (8), (9), (10), and (11), have been given in the following table.

Equation	Value	Equation	Value
2	3.1388	7	3.1414
3	3 1307	8	3.1576
4	3.0916	9	3.1416
5	3.1992	10	3.141596
6	3.1371	11	3.141593

It will be observed that the approximate formula (9), (10) and (11) are very powerful in giving a correct value of π. The above result is obtained only by taking ten terms of each series. Table 2 gives the value of π obtained with these formulae by taking twenty terms in each case.

Table 2

Equation	Value of
9	3.141594
10	3.141591
11	3 1415924

In Europe, the French mathematician Vieta was the first person to attack the

problem of evaluating π though the approximate value $\frac{355}{113}$, which had been obtained by the Chinese in the fifth century and which has also been stated by Nilakantha Somasutvan in *Tantra Sangraha*, was proposed in about 1573 independently by Valenton Otho and Adrison Anthonisz. They obtained this excellent value by taking the difference of the numerators and denominators of the values 22/7 and 377/120 proposed by Archimedes and Ptolemy respectively. In about 1590 Vieta obtained the infinite product.

$$\sqrt{\frac{1}{2}}\cdot\sqrt{\frac{1}{2}+\frac{1}{2}\sqrt{\frac{1}{2}}}\;\sqrt{\frac{1}{2}+\frac{1}{2}\sqrt{\frac{1}{2}+\frac{1}{2}\sqrt{\frac{1}{2}}}}$$

as the value of $\frac{2}{\pi}$. A little earlier he had calculated the value of π to nine decimals from the values of the trignometric functions of the angle $\frac{30^\circ}{2^{16}}$, i e., $\frac{225'}{8192}$ by continued bisection of angles.

But the mathematicians in Netherlands continued to use the method of inscribed and circumscribed polygons, due to Archimedes, and reached their goal by tedious calculation of square roots. In 1593 Van Roomen gave the value upto fifteen places by considering a polygon of $15\ 2^{24}$ sides. Ludolph van Ceulen obtained twenty decimals from polygon of $15\ 2^{37}$ sides in 1596, and later to thirtytwo decimals from the polygon of 4.2^{60} sides and finally to thirtyfive decimals.

In the seventeenth century two interesting formulae for π were proposed by two British mathematicians. One was an Irish Peer, Lord Brouncker, who proposed the formula

$$\frac{4}{\pi}=1+\cfrac{1^2}{2+\cfrac{3^2}{2+\cfrac{5^2}{2+}}}$$

The other formula was proposed by Wallis who was the Salvian Professor of Mathematics in Oxford. His formula was:-

$$\frac{\pi}{4}=\frac{2\times4\times4\times6\times6\times8\times\ldots}{3\times3\times5\times5\times7\times7\times\ldots}$$

The merit of these formulae was that they were not only much simpler than Vieta's formula, but have also the additional merit that each additional step makes them slightly more and the slightly less than the correct value, the difference decreasing with each step.

Spectacular advances were made after the discovery of Gregory's formula of which the particular form, for $t=1$, was discovered earlier by Leibniz But Leibniz formula converged very slowly and even by taking 50 terms we will get a value which will differ from π by about 0.1

Other formulae have been proposed which are more rapidly convergent than Gregory's formula. One proposed by Machin is

$$\frac{\pi}{4}=4\left(\frac{1}{5}-\frac{1}{3.5^3}+\frac{1}{5.5^5}-\frac{1}{7.5^7}+\ldots\right)-\left(\frac{1}{239}-\frac{1}{3.239^3}+\frac{1}{5.239^5}-\frac{1}{7.239^7}+\right)$$

Another is

$$\frac{\pi}{4}=\tan^{-1}\frac{1}{2}+\tan^{-1}\frac{1}{5}+\tan^{-1}\frac{1}{8},$$

$$=\left(\tfrac{1}{2}-\frac{1}{3.2^3}+\frac{1}{5.2^5}-\frac{1}{7.2^7}+\ldots\right)$$

$$+\left(\frac{1}{5}-\frac{1}{3\ 5^3}+\frac{1}{5.5^5}-\frac{1}{7.5^7}+\ \ldots\right)$$

$$+\left(\frac{1}{8}-\frac{1}{3\ 8^3}+\frac{1}{5.8^5}-\frac{1}{7.8^7}+\qquad\right)$$

This formula was used by Dase, who was born in Hamburg in 1824, to calculate π to 205 places in 1840. In 1854, Richter calculated it to 500 places and Shank in 1873 to 707 places. In modern times computers

have been used to compute π to several thousand places though as early as 1882 C.L.F Lindemann had proved that π is a transcendental number

Most of us are familiar with rational numbers Then we have irrational numbers and imaginary numbers. All these satisfy algebraic equations whose coefficients are rational numbers. For instance, $\sqrt{2}$ satisfies the equation $x^2-2=0$ and i satisfies the equation $x^2+1=0$ A transcendental number is one which satisfies no algebraic equation whose coefficients are rational numbers. Although it may appear strange. it was proved by G Cantor that transcendental numbers are infinitely more numerous than algebraic numbers and π is one of these

Elementary Number Theory, Prime and Composite Numbers, Fundamental Theorem of Arithmetic

V.I. BAULIN
Unesco Expert

and

R.C. SHARMA
Department of Science Education, NCERT, New Delhi

THE study of the properties of natural numbers, begun by mathematicians of bygone generations, has an important place in contemporary mathematics—forming the main content of one of its major sections, which we call the Theory of Numbers. Historically, the Number-theory emerged as an immediate evolution of arithmetic. In the Number-theory we first single out and consider those problems which are immediately connected deeply enough with the mathematical objects under study and which are important for constructing mathematics as a whole. Some of the problems belonging to the domain of the Number-theory have already been included in the course of school arithmetic. Let us consider some concepts and theorems connected with such problems.

1. Prime and Composite Numbers

Definition 1. A natural number more than 1 is called a prime number unless it has other divisors besides itself and 1.

Definition 2: A natural number is called a composite number provided it has other divisors besides itself and 1

The number 1 is neither prime nor composite.

Theorem 1: Any natural number exceeding 1 is divisible at least by one prime number.

Proof:

To prove this let us use the method of mathematical induction. Let us consider the least natural number more than one viz. the number 2. For this number, our assertion is valid as 2 is divisible by the prime number 2.

Let us now assume that this assertion is valid for all natural numbers which are more than 1 and less than the number n.

Let us prove then that the assertion is valid for the number n.

One out of two things is possible:

(1) n is a prime number;

(2) n is a composite number.

In case (1) the theorem is proved as n is divisible by n.

In case (2) $n = n_1 \times n_2$ (say) where $1 < n_1 < n$.

For the number n_1 the theorem is true. Hence n_1 is divisible by at least one prime number p. Then n is divisible by p. Let us illustrate it through an example.

Example: Take any numbers say 15,11.

15 is divisible by 5 and 3 (both primes),

11 is divisible by 11, which is prime,

Theorem 2: Any natural number is either divisible by a given prime number or they are relatively prime.

Proof:

Let us assume that a is any natural number and p is a prime number Let us indicate their greatest common divisor as d: d|p, when p is a prime number
Then d=p or d=1.

If d=p, then p|a, if d=1, then a and p are relatively prime numbers. Let us illustrate it.

Example. (i) Suppose $a=36$; p=11
36 is not divisible by 11.

∴ These numbers are relatively prime to each other

(ii) Suppose $a=132$; p=11

Here 132 is divisible by 11

Theorem 3: If the product or multiplication of 2 or more natural numbers is divisible by the prime number p; then at least one of the factors is divisible by p.

Proof. let us first prove it for two factors. Suppose $p/(a \times b)$. Two cases are possible:

(1) p|a; (2) a is not divisible by p.

In case (1) the assertion is proved In case (2) we can assert, on the basis of theorem 2, that a and p are relatively prime numbers and then p|b is true as p|$a \times b$.

Let us assume that the theorem is true, in case when the product includes fewer factors than k. Let us prove that in this case the theorem must be true also for the product of k factors.

Let us assume that p|n, n being the product of k factors, and that $n=a_1\times \ldots \times a_k$.

Using the associative law let us present n in the form of the product of 2 factors, for example, as follows:

$n=n_1 \times n_2$; where

$n_1=a_1$; $n_2=a_2 \times a_3 \times \ldots \times a_k$.

As it has been proved that the theorem for 2 factors is true, we may assert that at least one of the numbers n_1 and n_2 is divisible by p

Let us assume that p|n as n_2 represents a product containing fewer factors than k, then the theorem is true for n_2 and consequently at least one of the numbers $a_2, a_3, \ldots, a_k$ is divisible by p.

Example: Take $a=78$, b=21 and p=13

$\Rightarrow ab=78\times 21=1638$

ab is divisible by p, because $1638 \div 13=126$ and a is also divisible by p; because $78 \div 13=6$.

It illustrates the theorem.

2. Fundamental Theorem of Arithmetic

Any natural number more than 1 can be represented, and only in an unique way, in the form of the product of prime numbers.

Proof:

The proof of this theorem consists of 2 parts. In part (1) it is proved that it is possible to represent numbers in the form of the products of prime numbers, in part (2) the uniqueness of such a representation is proved.

Possibility

Let us use the method of mathematical induction to prove the above assertion.

Let us assume that n=2.

The assertion is true as 2 is a prime number and its representation in the form of the product of prime numbers is 2=2.

Let us assume that this assertion is true for any number less than n, n>2.

Let us prove, in this case the assertion is true also for the number n One of the two things is possible:

(1) n is a prime number.

(2) n is a composite number.

If case (1) takes place the assertion is proved. If case (2) takes place then suppose,

$n=n_1 \times n_2$; in which $Kn_1<n$ and $1<n_2<n$.

For numbers less than n the assertion is considered true and therefore $n_1=p_1 \times p_2 \ldots \times P_k$; $n_2=q_1 \times q_2 \times \ldots \times q_s$; where,

$p_1, p_2, \ldots, p_k$ and $q_1, q_2, \ldots, q_s$ are prime numbers.

Hence·

$n=p_1 \times p_2 \times \ldots \times p_k \times q_1 \times q_2 \times \ldots \times q_s$

Uniqueness:

Let us again use the method of mathematical induction.

Let us assume that $n=2$. The number 2 is a prime number and can be represented as the product of prime numbers in an unique way.

$2=2$

Thus for the number 2 the assertion is true.

Let us assume that the assertion is true for the number less than n. Let us prove it is true for n also

Let us assume that the number n is represented in the form of the product of prime numbers in 2 ways.

$n=p_1 \times p_2 \times \ldots \times p_{k-1} \times p_k$

$n=q_1 \times q_2 \times \ldots \times q_{s-1} \times q_s$.

Then

$$p_1 \times p_2 \times \ldots \times p_{k-1} \times p_k = q_1 \times q_2 \times \ldots \times q_{s-1} \times q_s \qquad \text{(i)}$$

Let us prove that $k=s$ and $p_1=q_1$, $p_2=q_2, \ldots p_k=q_k$.

The left hand side of the equality (i) is divisible by the prime number p_1 Consequently the right hand side is divisible by p_1. From theorem 3 it follows at least one of the factors of the right hand size is divisible by p_1. As we are not interested in the order of distribution of the factors let us assume that q_1 is divisible by p_1, but q_1 is a prime number, consequently it has no other divisors besides q_1 and 1. As $p_1 \neq 1$, it follows that $p_1=q_1$.

Let us now divide each side of the equality (i) by p_1. We obtain

$$p_2 \times p_3 \times \ldots \times p_{k-1} \times p_k = q_2 \times q_3 \times \ldots \times q_{s-1} \times q_s \qquad \text{(ii)}$$

Each part of this equality represents an expansion into simple factors of the numbers which are less than n.

For numbers less than n the assertion is considered to be true; consequently the number of factors in the left hand and right hand sides of the equality (ii) is the same, That is:

$k-1=s-1$ and consequently

$k=s$ and also,

$p_2=q_2$; $p_3=q_3$; $\ldots$ $p_k=q_s$

Example: Factorize 348:

2	348
2	174
3	87
29	29
	1

$\Rightarrow$ $348=2^2.3.29.1$

It cannot have any other prime factors.

Science Nobel Laureates of 1970

R. K. DATTA

Beth Israel Medical Centre, New York

THE 1970 Nobel Prize for Chemistry has been awarded to Dr. Louis Federico Leloir, 64 years old, Director of the Institute for Biochemical Research (Campomar Foundation) and Head of the Department of Biochemistry at the Faculty of Science of Buenos Aires, Argentina for "his discoveries of sugar nucleotides and their role in the metabolism of carbohydrates". The 1970 Nobel Prize for Physics has been shared by Dr. Loius Eugene Felix Neel, 65, of the University of Granoble, France, and Dr. Hennes Alfven, 62, now teaching at San Diego's University of California and at Stockholm's Royal Institute of Technology. Dr. Neel was cited for his fundamental work and discoveries concerning antiferromagnetism and ferrimagnetism. Dr. Alfven was cited for his pioneering work in magnetohydrodynamics (studies of electricity-conducting gases in a magnetic field) with fruitful applications in different parts of plasma physics. In recognition of their outstanding works in elucidating the chemical basis of nerve impulse transmission, three neurophysiologists from Sweden, Britain and the U.S.A. have been jointly awarded the 1970 Nobel Prize for Physiology and Medicine. The awardees are Dr. ULf Svante von Euler, 65 years old, Professor of Physiology at Stockholm's Royal Caroline Institute, Dr. (Sir) Bernard Katz, 59, Pro fessor of Physiology and Biophysics at London's University College, and Dr. Julius Axelrod, 58, chief of the section of Pharmacology at Bethesda's National Institute of Mental Health. This year's Nobel Prize for Peace has been awarded to a U.S agronomist who contributed substantially towards increasing the food production in Mexico, India, Pakistan, the Philippines and other countries The awardee is Dr Norman Ernest Borlaug, Director of the International Maize and Wheat Improvement Center in Mexico

Dr. Leloir

During studies over the last two decades Dr. Leloir discovered a class of sugar nucleotides which act as catalysts in the body metabolism, changing one sugar into another, combining sugars into polysaccharides and breaking down polysaccharides into smaller sugars. It was through his discoveries that the mechanisms of all the syntheses, transformations and breakdown of compounds belonging to the carbohydrate group were clarified. Born in France on September 6, 1906 young Leloir graduated from the Medical School of the University of Buenos Aires in 1932. He started research in carbohydrate metabolism with Dr. Bernard Houssay, who won the 1947 Nobel Prize for Medicine, in the Institute of Physiology of the University of Buenos Aires. Later he worked with Nobel Laureate Dr. F.G. Hopkins at Cambridge University, London (1935), with Dr. C.F. Cori (who shared the 1947 Nobel Prize with Dr. Houssay) at St. Louis.

Washington University Medical School (1943) and with Dr D E. Green at New York's Columbia University (1946). Upon return to Argentina in 1947 he was made the Director of newly founded Institute for Biochemical Research. In 1958 he was appointed Research Professor of Biochemistry at the Faculty of Sciences of Buenos Aires University, and since 1962 he has been the Head of Department of Biochemistry there. Recepient of many prizes and awards Dr. Leloir was the President of the Argentine Society of Biochemistry and the Spanish Society of Biochemists.

Dr. Neel

Born on November 22, 1904 young Neel received his education in Paris' Ecole Normale Supeiiure and got a D Sc. degree from the University of Strausbourg. He was a Professor there until 1945 when he moved to the University of Granoble. Since 1956 he heads a staff of about 300 at his Granoble laboratory where investigations are carried out in electronics, hydraulics, radio-electricity and applied mathematics. Recepient of many honorary degrees and awards from several universities in Europe Dr Neel is a member of the Royal Society of London and of Academies of Sciences at Paris, Moscow and Amsterdam.

Dr. Alfven

Born in 1908 young Alfven was educated at Uppsala, Sweden. He joined the Royal Institute of Technology in 1945 and became a Professor of electronics (1945-63) and a professor of plasma physics (1963-67) there. Following a difference with the Swedish authorities over insufficient funds for research concerning peaceful uses of the hydrogen bomb, he left Sweden in 1967. He received offers of professorship from both the U.S S.R. and the U.S.A. After two months in the U.S S.R , he moved to U S.A. and started teaching astrophysics at San Diego's University of California. Following a reconciliation with the Swedish authorities he now teaches six months in the University of California and other six months in the Royal Institute of Technology in Stockholm.

Dr. von Euler

In 1946 Dr von Euler discovered that noradrenaline was the nervous impulse transmitter in the sympathetic nervous system the part of the nervous system that responds automatically to emergency conditions within or outside the body. He also demonstrated how noradrenaline is stored in small nerve granules within the nerve fibres of this system Born on February 7, 1905 in Stockholm young von Euler earned his medical degree from Caroline Institute where he later spent most of his investigative career. As a recognition of his contributions to the knowledge of the nature of high blood pressure and hardening of arteries Dr. von Euler was awarded to share the 50,000 Stouffer Prize in 1967.

Dr. Axelrod

Dr Axelrod discovered the mechanism by which noradrenaline is inactivated when a nerve cell sends out impulses. He found that noradrenaline is inactivated enzymically by an enzyme called catechol-O-methyl-transferase. He also studied the effects of drugs on this mechanisms of inactivation of noradrenaline in attempts to find cures for schizophrenia and depressive state. Born on May 30, 1912 in New York young Axelrod received his education in New York's City College and New York University He worked as a biochemist in New York for 15 years before he joined Bethesda's National Heart Institute in 1949. In 1955 he was

appointed to his present position. It is said that his friends urged him to return to school to get his Ph D degree which he did in 1955 at George Washington University. He is blind of one eye as a result of an accidental blowing up of a bottle of ammonia.

Dr. Katz

Dr. Katz discovered the mechanism of the release of transfer chemical known as acetylcholine from nerve terminals at the nerve-muscle junctions under the influence of nerve impulses. Born in 1911 in Leipzig, Germany, he got his medical education in the University of Leipzig (1934) Later he migrated to England and started studies on nerve and muscle functions In 1939 he moved to Sidney, Australia, as a Carnegie Research Fellow and got a Ph.D. degree there. During the World War II, he served as a radar officer in the Australian Air Force In 1950 he returned to the University College of London where he became gradually a reader, a professor and the head of the department of Physiology, the position he still holds. He was knighted last year and is a member of the Royal Society

Dr. Borlaug

Dr. Borlaug improved wheat, maize and rice plants by imparting rust resistance, good milling and baking properties, higher protein, dwarfness to minimize top-heaviness and high yield. He made it possible for under-developed countries to solve largely the problems of hunger and poverty by cultivation of high-yielding grains. The credit of recent 'green revolutions' in some countries of the world is partly due to Dr Borlaug's improved and hybrid seeds. Born on March 25, 1914 in Iowa young Borlaug was educated at the University of Minnesota where he studied plant biology and forestry and won a B.Sc. degree in 1937. In 1940 he was awarded the M.Sc degree and the following year he earned his Ph.D. degree in plant pathology In 1944 he joined the Rockefeller Foundation, taking charge of the wheat-improvement projects carried out in cooperation with the Mexican Government Since then he has been working on breeding and plant pathology, mostly in Mexico, and supervising experimental agricultural stations in Mexico, the Philippines, India, Pakistan and Turkey. He also heads a team of scientists from 17 countries experimenting in Mexico with high-yielding grains In 1963, Dr. Borlaug came to India and decided to try his strains of wheat here. Today, it is said, about 80% of the land in the Punjab under wheat cultivation is planted with his 'miracle' wheat

Man The Killer of Nature*

U Thant

Secretary-General,
United Nations,
New York

FOR most of the time that man has been on earth, his numbers have been small and his power limited. Damage to his environment was at worst local, and usually subject to repair by the regenerative powers of nature.

Only a few centuries ago, in 1600 A.D. human beings numbered an estimated 500 million, and much of the world was uninhabited or unaffected by man's activities. In the past few centuries, however, the world's population has increased sevenfold and all areas of the earth's surface have been to some degree modified by man.

With the prospect of another doubling of the world's population in less than half a century, the need to provide food, water, minerals, fuel and other necessities for such increasing numbers of people will place pressure on virtually all areas of the earth and demand the most careful planning and management of natural resources.

Accompanying the growth of populations in recent decades has been the spread of urbanization. Forty per cent of the world's people now live in urban areas. In somewhat more than half a century, if present trends continue, urbanization will have reached its maximum and the great majority of people will live in towns and cities.

The rate of urbanization is more rapid in the developing nations. In 1920, the urban population was 100 million in these countries. By the year 2000, it may well have increased twenty-fold. In the developed nations, the urban population in the same period will have increased fourfold.

Urbanization is not in principle destructive to the environment. With proper planning and control, and if it were proceeding at a slower rate, it should enhance and not detract from environmental quality—by relieving pressure on rural lands, by providing goods and services in quantity and diversity by providing new and attractive habits and ways of life.

However, in most areas, governments have neither prepared for, nor have they been able to cope with, the mass migration into urban areas. In large cities, slums of the most wretched nature often become the environment of people who once lived in greater dignity and better health in the countryside.

Pollution of air, water, and land in urban areas have become universal problems. Diseases associated with urban living in developing nations have increased. Noise and congestion add to physical and mental distress.

Accompanying population growth and urbanization is the accelerated impact of

*Reproduced from the *UNESCO COURIER* Aug. Sept. 1970. The text is based on a study "Problems of the Human Environment" presented to the U N Economic and Social Council in July 1969 by U Thant, Secretary-General of United Nations.

industrialization, and of an advanced technology that is often poorly integrated with the needs of man and the environment. The production of crude petroleum was negligible a century ago. By 1966, however, it amounted to 1,641 million metric tons per year. Between 1937 and 1966, annual production increased six-fold. In the same period, the motor car, scarcely known at the start of this century, was produced at a rate that grew from 5 million to 19 million per year.

In the most recent decade, the total value of all industrial production has doubled. Industrialization is of vital importance to nations which seek to raise their living standards, but the side effects of poorly planned or uncontrolled industrialization and of the one-sided application of technology have been a direct cause of many serious environmental problems

The reliance of modern technology upon the combustion of fossil fuels has brought a 10 per cent increase in atmospheric carbon dioxide over the past century. This could rise to 25 per cent by the year 2000. The consequences of such an increase upon world weather and climate are uncertain, but could eventually be catastrophic.

The increased use of modern technology has brought major increases in the amount of waste products which pollute the environment. In the United States alone, this amounts each year to 142 million tons of smoke and noxious fumes, 7 million automobiles, 20 million tons of paper, 48,000 million cans, 26,000 million bottles and jars, 3,000 million tons of waste rock and mill tailings and 50 million million gallons of hot water, along with a variety of other wastes.

Other industrialized nations make their comparable contributions of debris and toxic materials, and while technology is adequate to cope with these problems of pollution, the planning and application of pollution control lags far behind what is required, often because of the cost

The spread of the urban-industrial network with its transport systems is consuming open space at a very high rate. In the United Kingdom, for instance, such expansion will consume one-sixth of the farming land in the next three decades. The spread of an urban-industrial-transport complex could enhance the human habitat, but too often uncontrolled urban sprawl destroys valuable resources, land-spaces and living things.

Expanding populations being increasing demands upon the productivity of agricultural lands for food and fibre Application of technology to these lands has brought greatly increased production but it is vital that such gains should not be offset by damage to the environment. Increased use of fertilizers and new varieties of pesticides have raised food crop yields, but some of these agricultural chemicals have side effects on the environment that we are only beginning to comprehend.

The maintenance of both atmospheric oxygen and the productivity of marine environments, for example, depends on photosynthesis by marine plants, mostly the floating algae of microscopic size. Minute amounts of pesticides such as D.D T. have been found to inhibit photosynthesis in these plants by 75 per cent. Yet we have dumped an estimated 1,000 million pounds of D.D.T. into our environment and are adding some 100 million pounds per year.

In the case of pesticides, world production now exceeds 1,300 million pounds The U S.A. alone exports over 400 million pounds per year. Apart from their potential effects upon the productivity of the oceans, many of these pesticides are known to have harmful effects upon fish, wildlife and human health, which have been of serious consequence in many areas.

The land upon which man depends for his food has been seriously impaired by man's own misuse. Five hundred million hectares (1,235 million acres) of arable land have already been lost through erosion and salinization, two-thirds of the world's forests have been lost to production and 150 kinds of birds and animals have become extinct because of man Approximately 1,000 species or races of wild animals are now rare or in peril. Erosion, soil deterioration, deforestation watershed damage and the destruction, of animal and plant life continue and in some areas are increasing

The environment of human settlements differs from all others in the degree to which it is created and controlled by man It would be expected that man, being presumably rational, would at least have constructed for himself urban centres ideally suited to his occupancy. In fact, the opposite often appears to be true, and it is within cities that some of the most acute problems of the environment are found

In most developing countries, it has rarely been possible to provide in advance the urban planning and design that would ensure a rational arrangement of space for living, working, transport and recreation, nor has it been possible to keep pace with the demands for housing, water supply, sewage disposal, education and the other amenities of urban life. Rapid urban development tends to overload every kind of public service, including transport and education.

The stress that often accompanies accelerated change results in motional tension and a feeling of insecurity. These in turn may lead to mental breakdowns, psychosomatic illness, suicide attempts and an increase of crime, drug dependence and anti-social behaviour

The deterioration of the physical environment, the natural as well as its man-made component, has social implications which can hardly be separated from the problem as a whole. Areas of natural beauty with an abundant wild life within reach of urban areas have a social function of 'providing recreation facilities for city dwellers, besides their intrinsic value as part of a common heritage.

Historic sites and monuments form a part of the man-made human environment, the value of which cannot be overestimated. Their cultural and social values for the individuals living close to them as well as for mankind as a whole are evident, and their conservation, along with that of the natural environment, merits the attention of the international community.

The magnitude of the problem in some developing nations appears to defy solution by anything less than a massive national and international effort. A first requirement is that of urban planning and design in which adequate consideration is given to the social needs of the population, including services. A second is for a major programme of construction and reconstruction In some places the establishment of complete new towns and cities with their own industries and other sources of employment may be called for There is great need to explore new patterns and frameworks for urban living based on greater understanding of human biology and behaviour and consideration of social and cultural factors.

The cost of such major programmes of planning and construction far exceeds any amount that has been expended on cities at any period in history The need is for new facilities to accommodate urban populations that will have increased twenty-fold over a period of only eighty years, from 1920 to 2000 A.D. The alternative to such

a programme is accelerating human misery and mortality

In developed regions the urban environment is afflicted with many of the same difficulties encountered in developing regions Urban planning and design lag far behind urban growth Where plans have been made they are often pushed aside by political, economic or social pressures

Unplanned or poorly planned suburbs spread over the countryside surrounding formerly well-defined urban centres, merging indistinguishably with those spreading out from other centres The result is an urban con-urbation, a poorly defined and little differentiated mass of urban tissue within which the individual has difficulty in identifying with a community, and is beset with problems of transportation, congestion and pollution. It is impossible to describe such areas as cities, but only as urbanized regions

Most developing nations lack specialists qualified to deal with the problems of urban planning and development Educational programmes should thus be drawn up with this need in mind. In the meantime, international agencies and bilateral assistance programmes will need to provide technical and financial aid to these areas.

Many national and international programmes are under way, but all fall short of existing needs Brazil has built an entire new city for its capital, but Brasilla is already plagued with urban slums Pakistan has taken a lead in the planning and design of Islamabad, but its overall urban problems are incredibly complex

Over $ 9 million are being provided to construct an experimental housing project in Lima, Peru, but hundreds of millions will need to be spent before the problems of the barriadas (shanty towns) can be solved. An idea of the cost of planning and building modern cities is given by the estimate from the 250 000 will cost $ 1,000 million.

One of the striking demographic features of today is the rural exodus set off by the stagnant economic and cultural life of the villages in many regions and the magnet of the city It is clearly impossible to provide the smallest villages with all the equipment and amenities of modern urban life. Nevertheless, if rural life can be made more attractive and living standards raised, fewer people will rush to the cities and more satisfactory patterns of land use can be developed

Many problems have arisen from the large-scale construction of dams, reservoirs, canals, power stations and other works for the movement and control of water in major river basins or the transfer of water between basins to provide for power, irrigation, transport or city water supplies

Such large-scale development programmes have been carried out on the Nile, Niger, Volta, Colorado, Columbia, Missouri, Volga, Rhone, Indus and many other river systems. Major interbasin transfers of water have been discussed for Canada and Siberia. Schemes to modify the entire Amazon River basin and to open a sea-level canal across the Panama Isthmus are under consideration.

Economic and engineering factors are given full weight in most of these plans, but the broader impact on the environment is inadequately considered. Often little or no attention is given to proper management of lands in the watersheds developed by engineering techniques. Among the harmful effects that occur are silting up of reservoirs, loss of delta lands, salinization, spread of waterborne diseases and the displacement of peoples.

In the marine environment there is an obvious need, already considered by the United Nations, for international control over the exploitation of marine resources and a system for making rational use of

these resources, which in the absence of effective control and management, have been and continue to be destroyed or depleted.

The decline of certain species of whales and seals, of sea turtles, of the Pacific sardine and the Atlantic salmon fisheries, as well as the continuing over-exploitation of the Eastern Pacific anchoveta fishery are examples. The growing dependence of man upon the sea as a source of protein requires that its resources be properly managed.

Pollution of the sea is a continuing threat to its future productivity. Although the International Convention for the Prevention of Pollution of the Sea by Oil has been in existence since 1954, oil pollution is still a major hazard, and other forms of equally damaging pollution, over which little or no control is exercised, continue.

Research on the problems of the human environment is in progress in most industrialized countries. At the international level, such programmes as the International Geophysical Year, the International Biological Programme, the International Hydrological Decade and the work of the Intergovernmental Oceanographic Commission have given a significant boost to research in important sectors of the environment

Nevertheless, more emphasis has been placed so far on research in the physical and earth sciences than in the biological and social sciences, and even in the most industrially advanced countries an ecological and integrated approach to research has rarely been followed.

Nor, as underlined by the Unesco Conference on the Resources of the Biosphere in 1968, is education at all levels and in all countries as yet designed to promote a proper understanding and appreciation of the nature of the problems of the environment. Only scattered efforts are being made in this respect in certain countries, mostly the developed ones, through an increased emphasis on ecology at the university level.

Very little educational material suited to the needs of developing countries is as yet available, although Unesco and the International Union for the Conservation of Nature are now working on the production of such material.

The training of specialists and technicians at all levels to handle problems of the environment is clearly a major need in the developing countries, where efforts are now being made to provide such instruction in national institutions. Similar education, appropriate to national conditions, is also given on a regional basis in institutions such as the Middle East Technical University at Ankara, the Training Centre for Sanitary Engineering in Morocco, the Turrialba Inter-American Institute for Agricultural Sciences in Costa Rica, or the Inter-American Housing and Planning Centre at Bagota.

But all the efforts made thus far to house population, to integrate technology into complex environments, to plan and control industrialization and urban development and to manage land and resources effectively have fallen far short of global needs. Today, therefore, all nations face dangers of critical proportions that call for action at the local, regional, national and international levels.

There are so many problems that choices must be made and priorities established. It is to analyse these problems and to provide a focus for world action that the United Nations has called an international conference on the Problems of the Human Environment, which will meet in Stockholm in 1972.

Some Important Botanical Gardens of India

G S. PALIWAL
Botany Department, Delhi University, Delhi

IN olden days, numerous gardens and beauty spots flourished in India which were meant for recreation only. During the Buddhist period some pharmaceutical gardens seem to have been established to grow medicinal plants. It was only during the 18th and 19th centuries that the Britishers established a few gardens with the intention of facilitating the exploitation of the plant resources of this country. No body would deny the great role played by the Indian Botanical Garden, Sibpur, Calcutta and Lalbagh Gardens, Bangalore, in the economic growth and horticultural developments of this country. Gardens also have their value in providing recreation to public and rousing their aesthetic sense. The present article outlines in brief the history of development of some of these gardens.

The Indian Botanic Garden, Sibpur, Calcutta

The Indian Botanic Garden which celebrated its 75th anniversary on July 6, 1962, has been a centre of interest to botanists and horticulturists for nearly two centuries. Some of the pioneer works on the flora of India, Burma and Malaya, as also the introduction of plants like tea, cinchona and mahogany are credited to this garden. At first the garden was the property of the East India Company, hence the name "Company Bagan" given to it by the local people. The epithet "Royal" came to be applied to it after the Queen's Proclamation of 1858 Royal Botanic Garden was renamed as the Indian Botanic Garden on the Indian Republic Day, 1950.

During the second half of the eighteenth century successive crop failures left Bengal in the grip of a serious famine. The widespread loss of human lives led to the search for some substitute or supplementary food plants which would not normally require a lot of attention. Col Robert Kyd, an army officer in the Company at that time, suggested the establishment of a nursery for growing a number of such plants as well as spice-yielding plants in which the company was trading at that time. It was also suggested that the nursery should grow teak trees which would yield the necessary timber for the repair of the Company's ships. The suggestion was duly approved and Kyd was entrusted with the task of establishing the garden. Thus the Botanic Garden came into existence in 1787, with Kyd as its first honorary superintendent. He was succeeded by William Roxburgh, who by his immense zeal and interest in Indian plants made the garden known to the botanical world. He introduced jute in the garden and exported the first 100 tons to the European market. However, during later years, he turned the commercial objectives of the garden to the background and more scientific aspects of plants and their identification became more and more important. He drew up a cata-

logue of the plants in the garden, the "Hortus Bengalensis" As Roxburgh did considerable work in the scientific study and description of Indian plants, he is aptly called "The Father of Indian Botany"

Wallich who took charge in 1817 occupied the chair for nearly thirty years He was followed by Falconer, Thomson, Anderson and C.B Clarke, the latter being one of the important collaborators of Hooker's "Flora of British India".

In 1864 came the great cyclone of Calcutta. It was accompanied by a huge tide from the Hooghly (Ganges) that flooded the greater part of the garden in some places to a depth of six to seven feet, and carried two ships inside the garden with great violence. This resulted in the destruction of nearly 1,000 trees and innumerable herbs and shrubs. A subsequent cyclone three years later further destroyed over 750 of the surviving trees

Dr King, who took charge of the garden in 1871, set his heart to reorganize the garden. A number of artificial lakes were excavated and with the available soil he was able to raise the general level of the garden. Many trees were planted and he tried to group them together on a geographical basis. The publication of the journal "Annals of the Royal Botanic Garden", Calcutta, also began in his time He was also responsible for the organization of the Botanical Survey of India in 1890. Dr. King was thus able to bring back the lost glory of the garden which once again began to draw the attention of visitors and scientists from far and near.

Dr. King was succeeded by Sir David Prain, Col. A T Gage, C.C. Calder, Dr K. Biswas and Dr. D Chatterjee. The last named met a tragic death in 1961 The present Superintendent of the garden is Dr. J. Sen

The garden is responsible for the introduction of a number of economic plants. The most important is perhaps cinchona which yields quinine Cultivation of jute, flax and hemp were also initiated through this garden. Other plants grown are vanilla, eucalyptus, paper-mulberry, nutmeg, cloves, cinnamon, pepper, mangosteen, potato, tobacco, coffee etc. As regards horticulture, it may be noted that a large number of exotic plants which are now found in the private gardens in India have all been introduced in the country through the agency of this garden. The giant water lily, *Victoria regia* was introduced from the Amazon in 1887 and still flourished. There are a number of orchids in the nursery and a fairly good collection of succulents

The chief attraction of the garden is, of course, the "Great Banyan Tree", whose age is said to be about 200 years. The present circumference of the tree is 1,328 feet and the height attained by one of its branches is 98 feet. It is interesting to note that the main trunk of the tree, which got decayed because of the attack of insects and fungi, was removed in 1925 and the tree is at present growing vigorously without its main trunk. There are also the large and the small palm-houses, the orchid house, Kyd's monument, the screw pine collection and the bamboos. There are approximately 12,000 plants in the garden from many countries.

The Herbarium of the garden contains the most valuable collection of plants from India and neighbouring countries; many of the types of Indian plants are carefully preserved here. The large number of specimens (about 2 5 millions) and the type materials add to the value of the Herbarium. Since April 1957, the major part of the collection has been transferred to the Botanical Survey of India

The Lloyd Botanic Garden, Darjeeling

The Lloyd Botanic Garden, Darjeeling is named after William Lloyd, who was an old and well-known resident of Darjeeling. In 1878, he donated to the Government of India, a beautiful piece of land to establish a garden in Darjeeling The garden is situated at an elevation of about 6,000 feet with an average annual rainfall of 110 inches These climatic conditions have enabled the garden to represent more or less the characteristic flora of the Sikkim Himalayas.

The garden which was laid out under the guidance of Sir George King covers an area of 40 acres With its wide variety of plants it is a paradise to the students and research workers in Botany and has come to be recognized as an eminent institution for the distribution of plants, seeds and specimens of the temperate and sub-temperate Himalayas to different parts of the world.

The garden is divided into three main sections. (1) an upper, containing indigenous dominant species of Eastern as well as western Himalayas and Burma, (2) a middle coniferous, and (3) a lower, containing exotic acclimatized specimens of different countries

There is an endless variety of form and colour in the ever-green and deciduous plants. The charming terraces and slopes, and the happy combination of alpine plants, geraniums, composites, azaleas, rhododendrons and various conifers leave an indelible impression on the minds of the visitors. The Rock Garden, the conservatories, the herbaceous borders and the annual beds are some of the usual interesting and colourful features of the garden. The spacious orchidarium contains over 2,000 orchids of all habitats.

The coniferous section is well planned and has more than 45 species The most remarkable among them is the Australian *Callitris* with evergreen bluish foliage. There are also two specimens of the Dawn-Redwood, (*Metasequoia glyptostropodes*). This beautiful conifer is of immense botanical interest since until two decades ago it was known only in the fossil state and it was only in 1944 that it was known discovered in the wild state from China. Of the other interesting trees mention may be made of the tulip trees (*Liriodendron elatus*) and a collection of exotic oaks (*Quercus* sp.).

The Herbarium of the Garden contains about 30,000 specimens covering nearly all the species of the Eastern Himalayas.

National Botanic Garden, Lucknow

The idea of establishing a Botanic Garden at Lucknow originated in 1929, due to an interest in the drug 'Santonin' obtained from *Artemisia maritima*. At that time U.S.S.R. was the only supplier of the drug to the world. A Kashmiri industrialist, Raja Daya Kishan Kaul requested Indian botanists to help him in finding a better source of the drug. Dr S.K. Mukherji and his student, K.N. Kaul, both of the Department of Botany, Lucknow University, approached the U.P Government for a small plot for the cultivation of medicinal plants at Sikandar Bagh, Lucknow. The proposal was accepted and in 1932 a plot in the Garden was assigned to the University with an annual grant of Rs 500. In 1934 Dr. Mukherji died and soon Professor Kaul was posted at the Royal Botanic Gardens, Kew, as Botanical Assistant for India. On his return to India in 1946, Professor Kaul again appealed to the U.P Government to convert Sikandar Bagh into a Botanic Garden. It soon grew into a small organization and in 1953 it was taken over by the Council of Scientific and Industrial Research.

Sikandar Bagh, originally a small garden founded by Nawab Saadat Ali Khan was so named by Wajid Ali Shah after his queen Sikandar Mahal Begum. In the centre of the garden was a small pavilion which was probably used by the Begum as a summer house.

During the uprising of 1857, the British artillery, destroyed most of the garden. In the years following 1857, the government seems to have acquired the land, on the south bank of Gomti and bounded on the west by the grounds of Shahnajaf* and on the east by Sikandar Bagh and Sultanganj area, for the establishment of a horticultural garden and thus the whole area including the royal garden came to be known as Sikandar Bagh.

With the incorporation of research in the activities of the Garden, it became necessary to provide with laboratories, library, museum and other concomitants of a research institution. Besides these, there are also the photographic section and an auditorium.

The activities of the garden include: (1) collection, introduction and cultivation of ornamental and economic plants, especially those of medicinal value and those yielding essential oils, (2) botanical, phytochemical and horticultural research, (3) supply of plants and seeds in exchange and otherwise to scientific workers and institutions in India and abroad, (4) training of personnel and (5) publication of scientific and semi-popular literature for the benefit of both research workers and laymen.

The scientific work is entrusted to a number of departments or sections. The main sections are Horticulture, Plant Collection, Phyto-chemistry and Soil Study Laboratory. A field laboratory for horticulture is established at the Banthra Research Farm, about 13 miles from Lucknow.

Among the more popular items of the garden are the orchards of citrus, mango and guava, the Rosarium, Woodland and the two beautifully maintained lawns. The palm house, the fern house, the orchid house and the cactus house lend grace However, the most lovely spots of the garden are the Climber Pergola, and the Portable and the Vertical gardens. In the latter ornamental, vegetable and fruit plants are maintained in baskets and pouches supported on poles in trays and wooden boxes, tree trunks, rocks and all kinds of odd objectives on which the plants can be grown.

Adjacent to the palm house is the Hydroponicum with the attached laboratory where various plants are grown in water and gravel cultures. Separate space has been allotted for experimental work, cultural trials, hybridization etc. The unprecedented floods of Lucknow during October 1960, caused great damage to the Woodland and the Experimental Plot.

A two year course for advanced training of botanists and agriculturists has been recently instituted. The course covers a comprehensive syllabus comprising systematic botany, plant morphology and physiology, plant tissue and organ culture, climatology, soils and manures, introduction, cultivation and propagation of economic and oranmental plants, laying out and maintenance of different kinds of gardens; plant improvement, storage of fruits and vegetables etc.

Government Botanical Garden, Saharanpur

This garden came into existence in the year 1779 when Muslim ruler, Zabita Khan decided to spend the revenues of seven villages for the maintenance of a garden at Saharanpur. The Maharattas also continued the same practice, and it was at the time of Marquis of Hastings that this garden was transferred to the administration of the East

India Company

The garden covered an area of 40 acres with sections for the Linnaean Gardens, and agricultural nurseries. In early days this garden played an important role in naturalizing many plants from America. Some of them were potato, tabacco, pineapple; guava, chillies, papaya, sapota, logwood, mahogany, *Parkinsonia*, *Argemone* and others Royle was responsible to a great extent for the furtherance of this garden. At the time of his retirement he not only developed it as a scientific institution but also left a huge collection of more than 4,000 species and about 30,000 specimens The plants were arranged under two systems; (1) the Linnaean or artificial classification and (2) the Jussieuan or natural method.

During later years the condition of the garden especially the Herbarium went on deteriorating and in 1876 Duthie was appointed as Superintendent. On his arrival he wrote "I found the Museum (erected in 1859) filled with miscellaneous collections including animals, mostly birds, as well as many kind of vegetable products such as fibres drugs etc. and in many of the glass cases sundry articles used in the manufacture of tea were exhibited. Other cases contained various rock specimens of Siwalik fossil remains. The Herbarium, such as it was, occupied a very subordinate portion of the Museum, for most specimens were unarranged, unmounted and for the most part unnamed".

Duthie immediately set to work saving what he could of the older collections. He toured and collected plants in the United Provinces and selected youths from the garden staff whom he trained as plant collectors. This resulted in the compilation of the compendious "Flora of Upper Gangetic Plains". The collections of mosses at Saharanpur represented the rich flora of the North-West Himalayas.

The present trend is to develop the garden for horticultural research The work on fruit trees such as mango, loquat and citrus is worthy of special mention, and it now serves as the Horticultural Research Station of the U.P Government.

Lalbagh Gardens, Bangalore

This historic garden has won a privileged place among the gardens of the world and has come to be regarded as one of the best in the East for its layout, grandeur, maintenance, scientific interest and scenic beauty Several foreign dignitaries have visited the garden and have been impressed by its beauty. Marshall Tito who visited India in 1955 expressed thus· "India is a garden and Lalbagh is the heart of it" Lalbagh houses and nurses plants from Australia, Africa and South and North America. It has introduced, acclimatized and multiplied edible, medicinal, industrial, ornamental and other economic plants from all other parts of the world over the past hundred years

Under the patronage of the Mohammedan conquerers, the splendid garden traditions of Central Asia and Persia had flourished in North India in the 15th and 16th centuries. In the South a similar garden called the Khan Bagh was developed in Siva by Dilvar Khan. Soon it drew the attention of Hyder Ali who initiated royal orchards in Seringapatam, Bangalore and Malavali The name Lalbagh was originally given to the garden by Hyder Ali owing to its profusion of roses and other red flowers. It is said that once Tippu (Hyder Ali's son) was taken to the garden by his father and the child spontaneously said "Lalbagh, Lalbagh" (red garden, red garden), and thus the name "LALBAGH" came to be applied to all the royal gardens of Hyder Ali.

Tippu Sultan was a great lover of plants and flowers, and he introduced many new species. He sent ambassadors to the Isle of France (Mauritius) in 1797 who returned to Mangalore the following year with twenty chests containing various plants and seeds. Apricots, apples, cashewnuts, guavas, dates, papayas, chinese oranges and various kinds of flowers were cultivated during the time of Tippu Sultan.

In 1799, Lalbagh was taken over by a military botanist, Major Waugh in the employ of East India Company and remained in his possession until 1819 He showed great zeal in the improvement of the garden and introduced several exotic plants.

Major Waugh in 1819 gave the garden as a gift to the Marquess of Hastings. Dr. Wallich, the Superintendent of the Royal Botanic Gardens, Calcutta, in the same year recommended the acceptance of this garden as a branch of Bengal Presidency Botanic Garden The Garden remained as a branch of the Presidency Garden under Dr. Wallich from 1819 to 1831.

On the British assumption of the Province of Mysore in 1831, Lalbagh passed into the hands of the Chief Commissioner. However, the credit of making Lalbagh a Botanic Garden under State control goes to one Dr. Cleghorn who was the chief conservator of forests in South India Later two Kew trained botanists named New and Black took charge of the garden and under their supervision each year witnessed improvements in this valuable institution. However, the greatest service to the garden was done by John Cameron, who held its charge from 1874 onwards. Vigorous and systematic introduction and expansion of the garden took place in his time. His particular interest was in introducing and acclimatizing plants of economic value of the State. The experimental cultivation of a number of crops such as cotton, rubber, fruit plants, coffee and dates was also attempted at his time. Ragarding ornamental trees and plants, Cameron was the pioneer in introducing all that was good in the world in the Mysore State.

Mr. Krumbiegoal assumed charge of the garden after the retirement of Cameron. In his time the tropical or more popularly named Indoor Nursery was established. In the year 1908, a statue of the late Maharaja of Mysore was erected and transferred from the Curzon Park at Mysore to Lalbagh. Now the Statue Garden is one of the best portions of Lalbagh and contains a collection of the best cannas Later, Rao Bahadur H.C. Jayaraja became the first Indian Director of the garden Extension of the work on both exotic and indigenous fruits led in 1932 to the establishment of a separate Fruit Research Station at Hessar ghatta, about 16 miles from Bangalore, under the guidance of the staff of Lalbagh.

The present Superintendent of the garden is Dr. M.H. Mari Gowda, who from 1951 onwards has been very enthusiastically developing this garden into a place of beauty and great scientific interest. In 1957 the garden celeberated its centenary. New areas have been acquired and they house the State Vegetable Breeding Station, the Tree Nursery, the School Garden and the Herbale Gardens spread over a total area of 240 acres. Thus, with its indoor and fruit nurseries, pot gardens, arboretums, economic garden, seasonal herbgarden, annual seed station and beautifully maintained lawns Lalbagh has great future and in the years to follow it may become the nucleus of horticultural development in India.

The Government Botanic Garden, Ootacamand

In the year 1948, the Government Botanic Gardens, Ootacamand, completed a hundred

years of valuable work on horticultural and economic plants. It is with the establishment of these gardens in 1848 that horticultural work can be said to have commenced in a systematic manner in the Madras State. With Mr. Mc Ivor from the Royal Botanic Gardens at Kew, the first incharge of these gardens, there were established plant industries of great importance in the country as a whole and in the State of Madras in particular. Cinchona, potato, a number of varieties of temperate vegetables, a range of tropical and sub-tropical fruits and a number of medicinal plants, essential oil plants, species and beverage crops now established in the Nilgiris are contributions from these gardens.

The plant industries of the Nilgiris play a great role in the economy of our nation. The tea and coffee produced from this garden is believed to be of the best quality in the world, contributing to the national wealth and foreign exchange. The introduction of the blue gum tree, yielding both a cheap fuel as well as an essential oil was also brought through these gardens For a long time these gardens have been the only source of the eucalyptus oil which came to be known as Nilgiri oil and is used in almost every Indian household as a medicine against chills, colds and fevers.

Ergot of rye containing the highest alkaloid content in the world (1 19 per cent of ergotoxine) was also produced in these gardens. The equable and temperate climate of these mountains had allowed the establishment of orchards of mangosteen which is said to be one of the most delicious fruits known. Avocado, durian, cherimoyer, persimmon, litchi and a host of other fruits were also introduced through the agency of these gardens.

The Botanic Garden, Yanam

This small but beautiful botanic garden which was established by Father A. Gangloff houses today not only indigenous plants but also those from Africa, America and Australia Situated in a small town at the confluence of the Godavari and Caringa rivers near Kakinada (Andhra Pradesh), the garden is spread over an area of about an acre. Father Gangloff exchanged specimens and supplied seedlings to other gardens and public institutions in India. After his death in 1957, the garden came under the charge of Father M. Mathai who has been doing his best to preserve and develop it further

Besides the gardens above described, there are a few other gardens of importance like the Victoria Gardens, Bombay, Moghul Gardens, Srinagar, Delhi and Agri-Horticultural Gardens of Calcutta and Madras. The garden attached to the Forest Research Institute, Dehra Dun possesses a large number of exotic and indigenous plants. It also serves as a good source of plant material for research purposes.

Conclusion

The various botanical gardens of our country are visited and enjoyed by millions of people every year In addition they have also served as great centres of research particularly in the fields of taxonomy, ecology and plant introduction It would be no exaggeration to say that history of the development of these gardens is linked with the botanical growth in this country. Also their great utility as a training ground for horticulturists is well recognized The utility of botanical gardens is best described in the words of N.F. Robertson who said, "Apart from stimulating the young and aspiring botanist, the gardens form a reference collection for horticulturists, pharmacists, biochemists, and a source of recreation for those who, while, not experts derive pleasure from the form and variety of plants."

Solid Gas

T. BARINOVA

OUR present life is almost inconceivable without the huge amount of products obtained from natural gas Nowadays mankind consumes billions of cubic metres of gas yearly and its gas requirement will rise in the future How long will the reserves of the blue fuel last? Can we suppose the Earth to contain some undiscovered deposits of this valuable raw material?

Natural gas occurs in porous rocks, where it is usually found in gaseous state or as a liquid (condensed deposits). But what is the state of the blue fuel in permanently frozen grounds? Soviet scientists were eager to clear up this question. The blue fuel had already been found in the Soviet zone of permanently frozen grounds and deep drilling had opened up only ordinary gas deposits. However, a group of scientists did not regard the question as settled They were intent on searching for such deposits which would contain gas in the solid state. Indeed, solid compounds of gas with water had been obtained in the laboratory. They have been called hydrates and are found to exist in crystalline form at 20-25°C and lower temperatures when the pressure is about 300 atmospheres. It had been found in Moscow at the Gubkin Institute of chemical and Gas Industry that such pounds could occur under natural cond as well. This had been proved by e ments where models simulated natural A theory had been evolved, but it re verification.

The scientists studied the data ob in prospecting northern regions and it necessary to reconsider the concepts f at that time on the geological struct gas deposits. And many facts ap in a different light. In Yakutiya, for ins the electric conductivity of some blu beds was found to be very similar to coal seams. Yet no coal was prese *was brought in evidence* by taking nun rock samples. On the other hand, already known at the time that the e conductivity of hydrate deposits wa times as high as that of gas deposits, c close to the electric conductivity of Was it not possible for some hydrate sits to be hidden here?

Remarkable Property

One of the previously discovered d was treated with substances which fav conversion of hydrate to free gas, and a great surprise, indeed, to see a huge ty of gas burst out of the opening. could not be interpreted otherwise t the presence here of the blue fuel in th state—a fact which nobody surmise tofore. Specialists recalled a mys event: drillers working in severe frost to a cottage to warm themselves an some excavated rock samples with While sitting around a fire they were by an explosion Nobody could then why the samples reminding of d had gone off Now it became clear had been hydrate lumps which pass

The newly discovered deposits have a remarkable property. One volume of water in the hydrate state binds up to 200 volumes of hydrocarbon gas Hence the growth of the amount of gas released from a gas well, viz., from 10-20 to 200-500 cubic metres a day—such is the result of conversion. It is well to remember that permanently frozen rocks cover about 47 per cent of the Soviet territory. Hydrate gas deposits are likely to add as much as 15 trillion cubic metres of gas to the country's resources of blue fuel, an immense wealth, indeed.

Yet how to make the gas rise up the well and direct it into pipes? It would be, of course, convenient to excavate the crystals to the surface, but gas hydrates cannot exist under ordinary conditions. They will vanish on their way to the surface owing to increase in temperature and reduction of pressure. So the scientists engaged in this research have developed special techniques of gas recovery from hydrate deposits, using conventional wells. The latter are equipped with setups by means of which the solid deposit is converted into the gaseous state in the bed. To that purpose various techniques are employed. For instance, pressure is reduced in the bed, and temperature is increased. To avoid a rapid decomposition of the hydrates with the ensuring explosion, the injection of substances which decomposes them is employed alongside of heating and reduction of pressure

Unexpected Qualities of Frozen Liquid

A Assovskaya

As a matter of theory, many substances can be brought to a vitreous state by freezing their melts rapidly enough. Yet in practice rapid cooling, except for familiar oxide glass, was successful only with microscopic quantities of substances.

Now, chalcogenide glass — the name coined for the materials synthesized at the Physico-Technical Institute—can be obtained in large volumes. This at once opened for them the road to commercial production. Interesting in the first place are the optical properties of the new glass, which, unlike oxide glass, transmits the infra-red region of the spectrum. Still more surprising are its electric properties. All of the known semiconductors are crystal structures, whereas glass was considered to be a typical dielectric. So the semiconducting behaviour of chalcogenide glass was a surprise.

The discovery of vitreous semiconductors has led to a radical change of many concepts in the physics of solids More than twenty years ago academician Abram Ioffe, the founder of the Physico-Technical Institute, suggested that the electric properties of matter depend definitely on the nearest order in the arrangement of its atoms. Characteristic of conductors and semiconductors is that the nearest order is combined with the remote order, i.e., the arrangement of their atoms is strictly periodical. Now, "frozen liquid"—vitreous matter —has only the nearest order at room temperature. Thus the very existence of vitreous semiconductors has confirmed Ioffe's hypothesis.

From the outside chalcogenide semiconductors have found application in tele-transmitting tubes of the "Vidicon" type. These devices have a high resolution, are sensitive to a wide spectrum range (from infra-red to X-rays) and possess the advantages of economy and small size Among the uses of the "Vidicons" with vitreous semiconductors are automatic control of industrial processes, defectoscopy and X-ray diagnostics, the latter requiring a much lower dose of irradiation.

"Silver starvation" is an expression familiar to specialists. In fact, silver is known to be an indispensable constituent of modern photographic materials Advancement in the domains of photography and motion pictures, where the consumption of silver is highest, calls for research aiming at the certain of silverless photography. One of the possible ways towards that aim is the use of light-sensitive materials made of vitreous semiconductors. Semiconductors of that kind can also be used as electronic relays

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Some Facets of Super-conductivity

CHHOTAN SINGH

Department of Science Education, NCERT, New Delhi

IN some metals an abnormally high electrical conductivity appears at extremely low temperatures. This loss of almost all resistance by certain metals at very low temperatures is called super-conductivity.

In 1911, Kammerlingh Onnes, while carrying on investigations within a few degrees of absolute zero with the aid of liquid helium, discovered that the electrical resistance of mercury becomes zero at about 4°K. Since Onnes's discovery the property of super-conductivity has been found in many other substances. Super-conductivity occurs at temperature below a certain value known as the transition temperature of the particular substance. Transition temperatures are slightly above absolute zero. Some metals such as Mg, Ge, Bi, Cu, Ag and Au are not super-conducting down to 0.05°K. A few super-conductors have comparatively high transition temperatures; among them are: lead (7.26°K), tin (3.69°K), aluminium (1.29°K) and niobium (9.22°K). Certain alloys also exhibit super-conductivity, usually when one constituent is a super-conductor and its crystal structure is preserved in the alloy. However, the alloy, Au_2 Bi is a super-conductor below 1.83°K, although neither constituent metal alone is a super-conductor.

One of the interesting phenomena of super-conductivity is the so-called perpetual motion of a current in a super-conducting circuit. When a current is established in certain metals at these low temperatures by magnetic means (without a battery), the current continues almost indefinitely with a barely perceptible rate of decrease. If current is induced in a simple LR series circuit at room temperature, it falls to 1/e of its initial value in a time $L/R \sim 10^{-5}$ second. However, for the super-conducting conditions, it is found that the current decreases by only about 1 part in 50,000 in an hour Using the most sensitive methods of detection, it has been established that the electrical resistivity of super-conductors is less than 10^{-20} ohm—cm, and for all practical and theoretical purposes it is zero Super-conducting currents, of course, generate no Joule heating in the metal, even for currents (observed in lead) as large as 370 amp, because of almost zero resistance of the super-conductors. So coils, made of wires of super-conducting material are used in electro-magnets required to produce intense magnetic field

Crystal structure has a close relationship to the onset of super-conductivity, the transition being much sharper in a metal single crystal than in a polycrystal. The transition temperature of a specimen under tension is raised, whereas hydrostatic pressure has the opposite effect. Evidence that lattice structure and vibrations are a determining factor in super-conductivity is also provided

by the discovery that the transition temperature of an isotope mixture of mercury, tin, lead, or tantalum varies with the average isotopic mass M, so that $T_c M^{\frac{1}{2}}$ is a constant for each element. This proves that the super-conducting state involves an interaction between electrons and lattice-vibrations. This is also consistent with the fact that super-conductors are not the best electrical conductors at ordinary temperatures; the greater interaction between electrons and lattice, essential for super-conductivity, lowers the ordinary electrical conductivity. These facts have been used by Burden and by Frohlich to advance theoretical discussions of super-conductivity that make plausible the $M^{\frac{1}{2}} T_c$ = Const law found experimentally and also provide a criterion for super-conductivity that may be expressed as, $\varrho n \upsilon^{-\frac{5}{3}} <$ critical value. Here, ϱ is the normal resistivity at O°C, n is the number of atoms per unit volume, and υ is the number of free electrons per atom This criterion is in general agreement with the observations, including the fact that super-conductors in general have a high resistivity at ordinary temperatures

Super-conductivity is also associated with unusual magnetic effects. The super-conducting condition can be destroyed by the application of a sufficiently strong magnetic field. This result may also be achieved by increasing the current flowing in the super-conductor until it produces the same critical magnetic field-strength at the surface of the conductor as is needed to suppress super-conductivity The relation between temperature and the threshold magnetic field-strength required to suppress the super-conductivity is $H = H_c \left(1 - \frac{T^2}{T_c^2}\right)$ where H_c has a characteristic value for each pure metal, eg , 29 Oersteds for cadmium and 818 oersted for lead.

Another phenomenon shown by a super-conductor in a magnetic field is the expulsion of the magnetic induction B from its interior. Before the metal is cooled below the transition temperature, the lines of magnetic flax pass through the conductor with only negligible bending However, on passing below the transition temperature, the magnetic field is forced entirely outside the super-conductor. In this respect a super-conductor behaves like a completely diamagnetic material with susceptibility $-\frac{1}{4\pi}$ This phenomenon was discovered by Meissner and proves that a super-conductor, in addition to possessing zero electrical resistance, also has zero magnetic induction (B = O).

Eddy currents are produced in a moving conductor by the interaction of an applied magnetic field with the conduction electrons. It would be anticipated since a magnetic field cannot penetrate into a super-conducter, such a metal would be free from eddy-current losses when moving in a magnetic field. This was found as expected for sphere of super-conducting tin, moving as a torsion pendulum in a magnetic field. The damping constant of the system is observed to increase greatly when the tin sphere passes from the super-conducting to the normal state. The change in damping is of the order of 10^6 and shows that the sidewise motion of the conduction electrons in a super-conductor is completely free, just as their longitudinal motions are

The thermal properties of super-conductors also differ from those in the normal state. As a metal passes into a super-conducting condition, its specific heat rises discontinuously by an amount proportional to T_c and a latent heat is observed when the transition occurs in a magnetic field. The thermal conductivity also changes when

a metal becomes super-conducting It then is markedly reduced as compared with the normal condition. This is explained by the fact that super-conducting electrons have zero entropy and so cannot contribute to the flow of heat Measurements show that the thermal conductivity of super-conducting tin at 0.65° K is 1/40 that of normal tin, and tantalum at 0 55° K has a thermal conductivity of only 1/60 of its normal value

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Classroom experiments

Overhead Projector with a Fresnel Lens

RAMAKRISHNA RAO VETURY
and
BHASKARARAMA RAO
Department of Applied Physics, Andhra University, Waltair

ALYEA type of overhead day light projector is very much recommended in the chemistry education to show the chemical reactions on the screen to the students, with the same idea the projector had been developed in the department of Applied Physics by us with indigenous components except the light source. The performance had been tested and found satisfactory. The principles of these projectors and the fabrication problems are discussed here.

Projector Systems

The purpose of a projector system is to throw on to a screen a highly magnified image of illuminated object, of comparatively small size. It therefore consists of (Fig. 1) a source of the light (1) and condensing lens (2) to collect the light from the source and provide a uniform illumination over the area of the object (3) under projection. The pattern of the projected object will obstruct and transmit light casting a replica of well defined shadows. A system of projector optics (4) collects this pattern and focusses a real inverted image on a screen (5) at a distance.

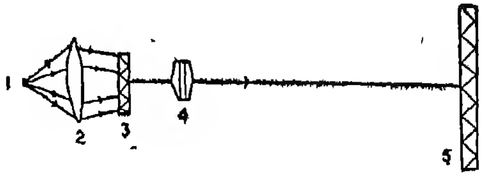

Fig. 1.

For the efficiency of the above system some factors have to be adequately provided. The projector optics has to be well corrected for projection of transparencies, letters etc. while the above criterion is not so stringent when the projector system is used for general purposes of shadow casting. The main problem, however, is one of providing uniform and adequate light, spread over the whole area of the object. For a given wattage of source of light, the source of light must be as near to the condenser lens as possible, so that larger solid angle is collected. The aperture of the condenser lens has to be bigger than the size of the object to be projected to provide a uniform illumination This results in a requirement that a condenser lens must have a short focal length and a large size. A lens like this invariably presents the problem of spherical aberration which rapidly increases with the square of the aperture of the lens, resulting again in loss of light received by the surface of the object. Besides, a lens made in glass will be too heavy and too costly. The average efficiency of an ordinary projector system is only about 5 per cent of the total light from the source reaching the screen. These difficulties are overcome in two steps (1) the use of a Fresnel lens which is self corrected for

spherical aberration like a parabolic mirror without requiring additional components (2) to make these Fresnel lenses in plastics the weight of which is negligible comparatively to the glass of similar dimensions and the cost of bulk production is also much less. Based on these considerations the Alyea type of projector has been designed in the following manner, using Fresnel lenses in position (2) Fig. (1).

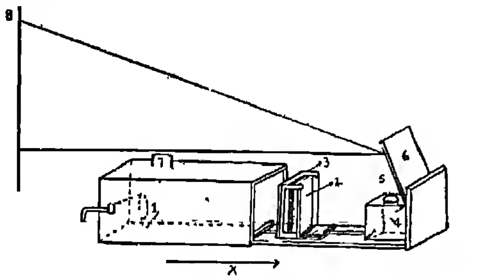

Fig. 2. Projector with a Fresnel lens

1 Light source 4. Mirror 7 Ventilating Fan

2. Fresnel lens 5. Projector lens System 8 Screen

3 stage 6 Mirror

Fig. 2.

The unit Fig (2) consists of a source of light (1) and a plastic Fresnel lens (2). The source is contained in a small box provided with a small ventilating fan (7). The Fresnel lens comes near to the open end of the box and is mounted on a stage (3) which can be moved to and fro along X direction for the fine adjustments. On this stage is also located the object for projection. In chemistry classes these cells can be independently moved for fine focussing on the screen The rays transmitted through the object are folded upwards by mirror (4) and pass through a projector lens system (5) which consists of two plano convex lenses placed apart. Another mirror (6) directs the beam on to the screen and can be adjusted for its inclination depending on the height of the screen (8) with reference to the projector. The distance of the screen from the projector is about 4 and 5 metres and the focussing is finally done by the movement of the object on the stage.

The whole unit is fabricated into two telescopic wooden boxes one sliding into another with a total over all dimensions of $18'' \times 7'' \times 7''$. While in use the total length increases to 33″.

Fabrication of the Unit

The whole unit excepting the lamp has been fabricated in the department. The projector system (5) in Fig (2) is made up of optical glass and the mirrors (4) and (6) are locally purchased The ventilating fan is also available in the country supplied by Electronic Corporation of India

Fresnel Lens

The nerve centre of the whole equipment is the Fresnel lens. Apparently, the methods of the design as well as production of Fresnel lenses is not known in the country This work has been taken up and based on the functional requirements of the Fresnel lens used in the present system, the lens has been theoretically computed. Using these computational values of number of lenses have been actually produced into two or three stages of developmental efforts The lenses have been tested photometrically as well as functionally and found to be quite satisfactory. Optical data $f = 8''$ $A = 5\frac{1}{2}''$.

The above lenses are produced separately by general engineering methods For bulk production further work has to be carried out to establish the methods of pressing on a master tool so that the cost of the lenses comes down to a reasonable value and all lenses will be indentical.

The results so far achieved establish the following points.

1. It is possible to design and produce plastic Fresnel lenses indigenously according to any functional specifications.

2. The successful computation enables us to make the lenses in any size without having copy of only one model.

Finally, the lenses are made on perspex sheets which are normally available in the market, though imported.

The projectors of this type can be easily produced in the country once the production of Fresnel lens is established The work can be taken up into two phases, (1) production of the projectors in small numbers using the Fresnel lenses made by our method (2) simultaneous work to be carried out to develop the bulk production methods outlined above and also improve the Fresnel lenses which has to be in progressive steps. These can latter be easily substituted for the earlier models.

The perspex sheets used by us are not of optical quality perspex but are found satisfactory for the specific use. As the Fresnel lens does not play a role in the image formation the quality of the material probably is not so very important within certain reasonable limits.

Light Source

The Alyea type of projector used two types of light sources (1) quartz iodine lamp with reflector and (2) an ordinary 150 watt 110 volts lamp The design and fabrication of quartz iodine lamp with reflector needs further investigational work, which will take considerable amount of work and money. With a certain amount of sacrifice in the intensity of the image, the quartz iodine lamp can be replaced by lamp 150 watt, 220 Volts Holland make. In the projector actually designed by us this type of bulb is used Alternative methods of producing higher illumination can however be tried with a possibility of success to replace the imported bulb. They may involve a few more components and dimensional changes in the projector.

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Science Ahead

The American Elementary Science Methods Teacher Today

DONALD A. VANNAN

Pennsylvania Clearinghouse on Methodology in Elementary Science State College, Bloomsburg, Pennsylvania

A nation-wide survey conducted this past summer 1969 at institutions of higher education offering a course typically called METHODS AND MATERIALS IN ELEMENTARY SCIENCE reveals that there are some important differences among the practices of college professors teaching this course

The survey was conducted by means of a mailed checklist A total of 150 elementary science professors were chosen by a process of rendom sampling from a publication of the National Science Teachers Association which was entitled "Opportunities For Summer Studies In Elementary Science," Summer, 1968. Usable responses to the checklist numbered 107, or a usable return percentage of 71 per cent. This percentage gives an indication of the interest shown in this type of national survey.

A total of 52 (48%) of the respondents held a Doctor of Education degree while 30 (28%) had completed their Ph.D. requirements. The remaining members held degrees in the following areas. (1) M.S., (2) M Ed , (3) M A , and (4) one faculty member held a L.L D. degree.

Exactly 27 (25%) replied that they used a basic textbook by Blough (Holt, Rinehart, Winston). The following authors were mentioned more than one time by the remaining 75%· (1) Victor—13 (12%), (2) Gega—10 (9%), (3) Craig—8 (7%), (4) multiple textbooks used—8 (7%), (5) Renner-Ragan, (6) Hone, (7) Kuslan-Stone, (8) Victor-Lerner, (9) Carin-Sund (10) A.A.A.S "Process Approach", (11) UNESCO Sourcebook, and (12) Kambly-Shuttle Several other textbooks received one mention and are not included in this accounting

The results indicated that 65 (60%) of those surveyed had taught in the public elementary schools full time before becoming a college instructor This speaks well for their general background for teaching prospective teachers how to teach elementary science It is essential to know children well and this can be best obtained by actually working with them for several years and to take "refresher trips" into classrooms occasionally to "keep in the swing" of the new generation It was also interesting to note that, of the above, 16 (24%) had taught 10 or more years on the elementary level before starting college work.

The requirements for science background courses before a student is allowed to take the methods course were many and, in some instances, non-existant The two largest categories which stood out well above the rest were the requirements of 1 full semester of physical science plus one full semester of

biology. Out of 215 possible choice indications, 54 (25%) indicated that "physical science" was required, and 49 (22%) stated that "biology" was a required course A discouraging 11 (5%) informed the researcher that "there are no specific requirements."

An impressive 78 (72%) answered that they required their students to teach short sample lessons to their peers in order to give them some "practical experience" in teaching. In addition, 66 (62%) indicated that they did *not* require, their students to teach short sample lessons to clementary pupils in a lab school or elementary school. In the researcher's area, the lab school has been changed to classrooms and offices and a learning center will be constructed in the future. The public schools would not welcome a large mass of students to teach the sample lessons described above.

A distinct majority, 73 (68%), informed the researcher that they were assigned to the Education Departments at their institutions. Only 29 (28%) were listed with the Science Departments. A few were assigned to either the Science/Education Department or the Biology Department.

What about science equipment and materials? Do students get an opportunity to gain experiences with them? The number of professors who gave students personal experiences with at least 25 pieces of equipment was 72, or 67% of the population. This, in the researcher's estimation, is an excellent practice. With children's science toys achieving a high level of sophistication (such as Gilbert, and Porter Brothers' labs), the need to be able to indentify and use equipment is of distinct importance in education today.

The requirement that "students are asked to write at least one lesson plane in science" was approved by 89 (83%) of the survey group. In addition to the lesson plan, 63 (58%) indicated that they also requested a full unit to be developed in some area

When asked, "Do you teach or have the students research the major national programs in science?" the reply was: (1) 47 (51% of possible 92 choice indications) stated that they *taught* the programs, and (2) 45 (49% of 92 possible choice indications) replied that they had *students research* the programs. The programs included A.A.A.S., S.C I.S., E S.S., etc.

A total of 75 (70%) of the professors offered a *science consultant service* for teachers in their service areas. The researcher offered a free cosultant service beginning in November of 1967; the program had to be dropped in September, 1968, due to lack of interest shown by area teachers. The respondents did not write or have someone write a *science column* in local newspapers; 4 (3%) indicated that they had such a newspaper column in their local publications. This is an area of college-community relations which should not be overlooked. It is just good public relations and serves a definite need in most districts, especially for science minded children and their teachers. A similar column, begun in the Bloomsburg area, however, had to be dropped after 6 months due to lack of interest of the teachers and pupils. This does not mean that the column is not a good idea, it is. It should be tried in many areas; a column of this type might be the only science news in the area.

Will elementary science professors travel if requested to speak at conferences and meetings? The answer is a resounding YES; A total of 81 professors agreed to come to Bloomburg from all over the country, if requested, to speak at an annual education conference This is good; this is as it should be.

As a final word, it should be noted that all of the data from the survey has not yet

been thoroughly digested and analyzed A future article will attempt to draw some conclusions about specific teaching techniques employed by each professor The data is on the survey forms, it will be abstracted and put under close scrutiny in the near future.

Message on Environment

The great public awareness of the pollution in the environment and the necessity to maintain the purity of nature is reflected in the following letter which an American couple is sending to all their friends in place of a Christmas card. It might appear that the problem is not so severe or acute in India, but it is better to get prepared on this front and take early precautions so that we might not repeat the mistakes done by the developed countries

EDITOR

Dear Friends,

We wish each of you a Merry Christmas, health, meaningful and satisfying relationship with others, and a life in harmony with the Golden Rule and with nature. The members of our family are well and actively involved in their work and in facing the problems of our society

Instead of our usual Christmas letter we are sending you some information together with our views regarding the environmental crises.

Following are some excerpts from an address by Paul F. Brandwein at a recent International Conference on Education and the Environment in the Americas held in Washington, D C. at which I was invited to participate·

Propositions Toward the Survival of Ourselves, An Endangered Species.

(1) The present million or so species of organisms, including man, have come out of a history traversing several billion years, presumably from one primitive organism. This is evolution. Man is a co-inhabitant with all other species

(2) The environment available to organisms is limited Further, any species of organisms is adapted to a special environment and to a special ecological niche; in all probability no other species can occupy the same ecological niche. All organisms have a place in the link of living things Many species die of that which makes them great. Are we to die of the technology that made us great? Man does not fit the ecosystem of which he is a part Man makes a lousy dominant. Man is not yet civilized. He destroys not only himself but also his co-inhabitants.

(3) The environment is finite. Species have particular adaptations yet the growth of the population is held in natural check by various combinations of starvations, disease, predation, and conflict

(4) Man as a dominant has conquered or is on the road to conquer all his natural predators and disease.

(5) The production of organisms proceeds geometrically, so too does the production of man 1 billion by 1850; 70 years later 2 billion, 35 years later 3 billion, 15 or 16 years later 4 billion (1970). By the end

of the century from 6 to $6\frac{1}{2}$ billion people

(6) The problem of the increase in population cannot be solved by increasing the production of food

(7) Biological evolution is the transmission and transmutation of genes or DNA. For man this is no longer in effect. Instead what operates is cultural evolution, the transmission and transmutation of knowledge and values

(8) Natural and cultural evolution together determine which species shall survive May we not save man?

(9) The concepts and values man accepts and imposes on his behavior determine which living things shall survive including man himself.

(10) The rational and hopeful solution that man may seek a culture relevant to the modern century, to make technology servant rather than master ., I think would require a global resource policy It will not do to have food in the United States and starvation in India. We require a global population policy. It will not do to control the population here and not elsewhere.

(11) There is still time to develop a sanative environment

(12) We have reached a cultural and biological point of no return.

What kind of a world do we want for our children? We want a world free of pesticides, in which a Judean-Christian ethic prevails, a world with compassion, truth, beauty, and love. But we are dominant and degenerate. We need a moral sense.

Following are some excerpts from an article by Walter G Rosen in the November 15, 1970 issue of Bio Science entitled, "The Environment Crisis: Through a Glass Darkly."

"The ultimate problem, of course, is too many people . The best estimates of optimal world population are less than one billion. We have at present 3.5 times that number And we all know that the high material standard of living which we enjoy generates ever-increasing per capita consumption of the fruits of our technological genius

"It has been estimated that in terms of damage to the environment (garbage production, consumption of energy and nonrenewable resources; removal of land from primary productivity, etc) each American can be thought of as being the equivalent of 25 to 250 Indians, i e , each of us does as much damage to the environment as that many of our "underdeveloped" brothers.

"We are thus faced with the obvious necessity for a halt to the population explosion More specifically we are in urgent need of world wide zero population growth, in some places of negative population growth And equally importantly, of reexamination of the wisdom of unfettered economic growth. This implies a redefinition of our concept of what constitutes a desirable standard, or style of living

"It occurs to me that we have made the honest, thoughtless mistake of transposing from English common law a precious value when applied to *people* and made it a pernicious precept by applying it to *things*· "innocent until proven guilty " It seemed, until recently, reasonable to apply this rule to "things," including synthetic molecules, combustion products, food additives, pesticides, medicines, packaging materials, highways, airplanes, explosives, dams and rockets. By now we ought to have learned otherwise The fission products of nuclear bomb testing ought to have taught us if radium

did not. Thalidomide ought to have taught us, and, DDT. But all of these experiences notwithstanding, we continue to assume that damage must be demonstrated before restraints are invoked This 2,4,5,—T has been unequivocally demonstrated to be teratogenic and its use in Vietnam and in this country have been restricted. But as Thomas Whiteside pointed out in his recent book on defoliation, 2,4,5,—T had never been tested for teratogenicity, or for any other form of human toxicity, before the first birth defects were reported from Vietnam.

The application of "innocent until proven guilty" concept of thermal pollution, defoliation, irrigation systems high rise buldings, supersonic transports, etc , is too obvious to require elaboration It is also too obviously wrong to require lengthy analysis We have tinkered with the environment recklessly with occasional dire results. We continue to tinker in a manner that invites disaster.

Tinker is a most inappropriate verb. We have intervened massively, to the extent of upsetting ecosystems, destroying species, altering the composition of the atmosphere, the depth of the topsoil, and the climate of vast regions of the earth

(Our survival is in danger) "We must act rapidly and radically Not only in college, but at every level from kindergarten through graduate school we must teach relevant science, ecological awareness, and the responsible kinds of behaviour which follow therefrom Charles Sibberman has stated well, albeit in very general terms, the principles which underlie the kind of education I am trying to describe:

"To be practical, an education should prepare a man for work that doesn't yet exist and whose nature cannot be imagined. This can be done only by teaching people how to learn, by giving them the kind of intellectual discipline that will enable them to apply man's accumulated wisdom to new problems as they arise, the kind of wisdom that will enable them to *recognize* new problems as arise. Education should prepare people not just to earn a living but to live a life: a creative, humane, and sensitive life. This means that the schools must provide a liberal, humanizing education. And the purpose of liberal education must be, and indeed always has been, to educate educators—to turn out men and women who are capable of educating their families, their friends, their communities, and most important, themselves "

"We hear talk of an *Ecological Bill of Rights* I submit that the very phrase reflects our mistaken perceptions. Rather than rights (freedoms for ourselves), we need a new set of *Thou Shalt Nots*, an ecological Ten Commandments, with emphasis on restraints rather than on freedoms.

(The basic restraint should be)· "Thou shalt stop at two children remember you are a part of an intricate food web and if you deny other creatures their living space you are depleting . . . (the life support system) and upsetting the food webs on which you depend We must get off the back of nature, which we are breaking, and back into nature, of which we are a part. We must consume less and recycle more We must begin with ourselves. We must struggle along without electric toothbrushes. We must not use the internal combustion engine (or any other engine, however less polluting, since their manufacture requires so much energy), when we can walk. We must live lower on the hog, which nutritionally means lower on the food pyramid."

In our view, the urging population with the resulting exploitation and pollution of

the environment has gone so far that man's survival depends upon immediate and drastic changes in his behaviour. So we urge you this Christmas season to consider how each of us can function as an individual and as a citizen to preserve a hospitable environment for our children.

Individually, we can consume less and hence pollute less in these ways.

1) waste no food
2) eat more grains and less meat
3) use less tobacco, alcohol, and drugs
4) use returnable containers for beverages
5) dispose of trash in appropriate ways
6) save, sort, and return for re-use aluminum cans, scraps of non-replaceable metal, paper, et. al.
7) use no phosphate detergents
8) use less of detergents, soaps and other chemical cleaning materials
9) walk more, drive less and in smaller cars
10) help out children value more simple recreations and less 'first backs', drag racing, et. al.
11) keep our cars in 'ship shape'
12) use lead-free gas
13) economize on the use of electricity
14) emphasize style more and fashion less
15) use no defoliants or other harmful herbicides
16) use no non-biodegradable or heavy metal pesticides
17) use fewer pesticides and herbicides
18) instill in our children a respect for all life; a desire to defend our wilderness; a desire to prevent pollution of air and water and soil
19) be more concerned for the safety and welfare of others
20) limit the size of our families

As citizens we can actively work for legislation and for enforcement of laws to require man to live in harmony with nature rather than exploit it:

1) make birth control information and means available to all
2) legalize actions to prevent birth of unwanted children
3) support zero population growth everywhere
4) stop mass media from promoting sale of tobacco, alcohol and drugs
5) make disposal of accompanying wastes a part of cost of production of goods
6) require adequate sewage treatment plants
7) support plans to remove nutrients from effluent of sewage treatment plants, by using it for irrigation purposes before returning it to steams and lakes.
8) limit dredge and fill operations on inland lakes
9) resist channelization streams
10) prevent destruction of estuarine waters essential to life in the oceans
11) stop flow of mercury, lead and other heavy metals into lakes, steams and oceans
12) stop use of persistent pesticides
13) stop use of defoliants and other harmful herbicides
14) establish and enforce national standards on air and water pollution and international standards on pollution of oceans
15) stop dissemination of non-replaceable metals in refuse
16) require that total cost to the environment studies be made before permitting any proposed development
17) focus attention of everyone on effect on the environment rather than on an

increased gross national product (GNP)

18) limit the size of airplanes
19) prevent development of supersonic transport (SST)
20) eliminate wanton rape of environment at wars.

Analysis By Flames

THOMAS S. WEST

Chemistry Department, Imperial College of Science and Technology, London

Until fairly recently the most commonly used method of analysing trace metal constituents (i e less than 0 01 per cent or one hundred parts per million) in all sorts of materials consisted of dissolving the sample and adding an organic compound which formed a characteristic colour with the trace metal ions, but not with the other metals present.

THE intensity or light absorption of the colour was then measured by means of a spectrophotometer and the trace metal constituent was measured from a knowledge of the relationship between the colour intensity and the amount of metal ion required to produce such a colour. Unfortunately it is scarcely ever possible to find a chemical reaction which produces a distinctive colour with a metal ion and not simultaneously with several others. For this reason, numerous chemical separations have to be done to separate and preconcentrate the trace metal ion from virtually all others This process is usually time consuming as well as costly and, in the lower reaches of trace analysis, where one is dealing with parts per billion of trace constituent, it is often found that the chemicals and apparatus used introduce significantly greater amounts of the metal being sought than were originally present

Even where fairly selective colour forming reagents are available the absorption spectra bands may be so broad that it is not possible to pick out the absorption due to one metal from that to another. The corresponding technique of spectroflourimetric analysis in which the addition of an organic molecule produces a fluorescence emission is a good deal more selective and sensitive, but unfortunately not very many useful fluorescence reactions were known until recently and there was a dearth of worthwhile apparatus, Nevertheless, light absorption (colour) and, to a much lesser extent, light emission (fluorescence) methods, together with a few electrochemical procedures, have formed the basis of practically all trace analysis procedures for metals and non-metals.

These procedures rely on molecular light-absorption and fluorescence phenomena in aqueous or organic solvents. Free atoms also exhibit absorption of light and are capable of emiting fluorescence when suitably stimulated. Free atoms do not normally exist in condensed phases (liquids and solids) though aggregates of free atoms do. The phenomenon of atomic absorption of light by metals can, therefore, be measured only in the gas phase To prevent condensation of metal atoms, an elevated temperature must be used to generate and maintain a dispersed population of atoms For this reason flames are commonly used to generate atoms for analysis and the measurement of atomic absorption is generally made while the atoms are within the hot plasma of the flame. The sample for analysis is dissolved and the

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solution nebulized, is broken down into a very fine mist, and blown into a pre-mixed air-hydrocarbon flame on the air stream which is supporting combustion of the hydrocarbon Within the flame plasma, the processes shown in Figure 1 occur. It must be realized, of course that the atoms are being generated continuously in the flame and pass out of it with approximately the same speed as the combustion products of the flame itself. Shortly after leaving the flame, the atoms will normally be completely oxidised in the upper regions of the flame If they are not chemically combined upon leaving it, they will rapidly condense in the cool atmosphere outside the plasma Consequently, measurements of light absorption by the metal atoms, are usually made low down in the flame immediately above the primary combustion zone where the highest density of metal atoms is found. Flames are available for the production of free atoms of almost all elements and thus, provided that gas supplies to the flame and the flow of solution mist on the support gas are maintained constant, there is a satisfactory flame "atom-reservoir" available for any trace metal which may be required

All free atoms are capable of absorbing light in the same way as molecules. Light is an electromagnetic disturbance of the ether through which it passes. The only way in which it can interact with matter is, therefore, to produce an electromagnetic disturbance in the matter. It does this by moving the outer electrons of atoms or molecules from their normal (ground-state) atomic or molecular orbitals into orbitals of higher energy as depicted schematically in Figure 2(a). The excited electrons can fit only into certain orbits around the atom or molecule, i.e they can be fitted only into predetermined energy levels which are dictated by the "selection rules" of spectrochemistry Thus, wavelengths of light will be absorbed by atoms or molecules only if they correspond exactly to energy gaps between the permitted excited states and the ground state of the electrons in the absorbing species Molecular spectra show only broad absorpion bands because, associated with each individual electron transition, there are multiple vibration levels within the chemical bonds of the molecule and also numerous rotation energy levels. This smooths out or damps the many possible electron transitions even for a simple molecule so that broad bands are almost invariably seen. These vibrational and rotational features are completely absent in free atomic species. Thus atomic spectra appear as sharp lines of very narrow half-intensity widths of the order of only 0.001 mm even allowing for all the broadening influences in the flame medium.

This very narrow absorption profile makes the phenomenon of atomic absorption uniquely selective. Approximately 10^5 atomic lines can be packed into the same spectral band-width as one absorption band of a molecular species in solution. Dr. Alan Walsh, FRS, of the Department of Chemical Physics of the Commonwealth Scientific and Industrial Organisation in Melbourne,

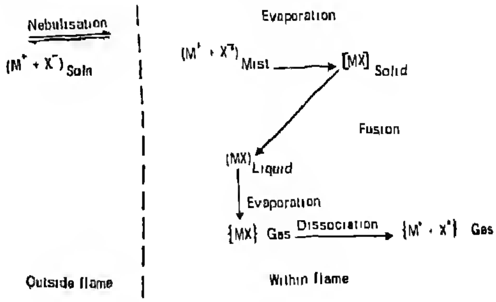

Fig. 1.

Processes leading to the production of atoms in flames.

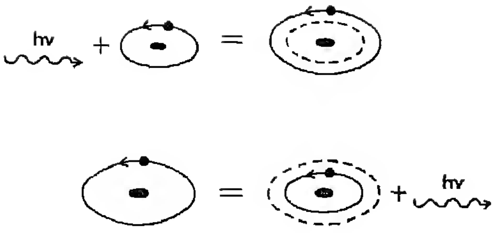

Fig. 2
Schematic illustration of atomic absorption processes.
Top *Excitation or absorption of light.*
Bottom *Emission of light by an excited atom.*

who has developed the technique, realised that the chief problem was to obtain a method for measuring absorption at the centre of an atomic line He decided that it was not really feasible to monochromate the light from a continuum source, as in solution spectrophotometry, because the band-pass of the best monochromators of conventional design was much wider than the halfwidth of the atomic absorption line

Specificity does not mean that accompanying elements will not interfere by physical effects. Usually any such interference can be minimised or eliminated by passing to a hotter or more reducing flame. Virtually all the major sources of difficulty due to matrix elements cause loss of sensitivity because of the formation of refactory compounds with the element to be determined or because of the physical sequenstration of the trace element in matrix "clots" which are not gasified in the flame. Simple and effective methods are usually available to overcome such problems when they arise, however.

The range of elements that can be determined by atomic absorption is shown in Figure 6. With a few exceptions, e g , Ce, Th, most of these elements can be determined in tenths or hundredths of a part per million of solution A few can be determined in thousandths of a part per million.

Fluorescence in atomic spectroscopy has recently shown itself to be equally specific and considerably more sensitive than the, now established, absorption technique Work at Imperial College has pioneered atomic fluorescence spectroscopy and parti-

Li	Be											B					
Na	Mg											Al	Si				
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se		
Rb	Sr	Y	Zr	Nb	Mo		Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi			
			Th		U												

Ce	Pr	Nd		Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

Fig. 3.
Range of elements determinable by atomic absorption spectroscopy.

cular use has been made of the separated flame technique which lowers flame backgrounds by several orders of magnitude. Work on very high intensity spectral line sources — Microwave Excited Electrodeless Discharge Lamps — has produced sensitivities ten and even one hundred times greater than that obtainable by atomic absorption. Lastly, the most significant development of all may prove to be that of fluorescence used in conjunction with a resistively heated graphite flament "atom-reservoir". This can be fitted on to any commercial instrument in place of a flame and allows amounts of metals as low as 10^{-14}g to be determined in as little as 10^{-6}1 of sample solution, thus challenging and surpassing the sensitivity of spark source mass spectrometry and even radioactivation analysis, with apparatus costing only a total of £ 1-2000. This flameless technique should also extend to the analysis of traces of the non-metals, e g., sulphur, phosphorus, etc.

Undoubtedly, atomic absorption and atomic fluorescence spectroscopy have had and will continue to have a profound influence on the future of trace metal analysis for many years to come.

Flames suitable for various elements

TABLE 1

Flame	Elements
Air/hydrogen	As, Se, Sn
Air/propane	Ag, Cs, K, Li, Na, Rb
Air/acetylene	Ag, Au*, Ba, Bi, Ca*, Cd, Co, Cr*, Cs, Cu, Fem Ga, Hg, In, Ir, K, Li, Mg, Mn, Na, Ni, Pb, Pd, Pt, Rb, Ru, Rh, Sb*, Si*, Tl, Zn.
Nitrous-Oxide/ Acetylene	Al*, B*, Be, Ce, Dy, Er, Eu, Ge*, Gd, Hf, Ho, La*, Lu, Mo*, Nb*, Nd*, Os, Pd, Re*, Sc, Sm, Si*, Ta*, Tb, Th*, Ti, U*, V*, W*, T, Yb, Zr*

*Denotes fuel-rich flame.

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The Cause of Ageing

The human body grows old because the cells, of which it is built, individually grow old and die. In other words, the answer to the problem of old age, if it is a problem, lies within the living cell Research in molecular biology has shown that the basic structure of living cells, is common no matter how specialised they may be From this it is obvious that if an explanation for the process of ageing can be found for one kind of cell, then it is more than likely that the same explanation will apply to most if not all other cells.

Since the discovery that DNA carried the blueprints which controlled the manufacture of the cell, scientists have been trying to pin ageing on to damaged DNA. Several have suggested that DNA may be damaged at intervals, for instance by radiation and that this continual damage to the central blueprint can cause an accumulation of faulty parts of a cell Consequently this accumulation eventually kills the cell. An advanced version of this theory has now been put forward by Dr Steven Pelc of the Medical Research Council's Bio-physics Research Unit in London.

In this, Dr. Pelc suggests that the central DNA itself is not damaged but rather some of the copies of the blueprint. Up to 200 copies of this central blueprint, are made during the life of a single cell and that it is damage to these copies which causes the ageing process. The theory makes sense for two reasons. First, the central DNA is copied to provide working blueprints early on in the life of a single cell, after which time the central blueprint is wrapped around by a sheath of protein which protects it until it is time for the cell to divide (cells multiply by division). This means that when the DNA code in a cell is passed on to a daughter cell, it will be intact, without having the defects that eventually killed

the parent cell. Dr Pelc's theory explains how the sort of damage which causes ageing could be limited to one cells own life cycle and so prevented from spreading around the body as the cell multiplies.

It also makes sense for a second reason, if the thousands of "factories" where the cell makes its new working parts, are to do their job efficiently, then they should obviously have plenty of blueprints to work from, not just a single central one If so, then one might expect a living cell to need several copies of its central blueprint when it has to work especially hard Dr Pelc has shown that this does infact occur. The cells that secrete hormones in mice produce extra quantities of DNA, when extra amounts of hormones are required.

There is more evidence to support the theory. It is known, for instance, that most living cells produce new DNA during their life. The theory also explains why single celled animals, called *Paramecia*, have two nuclei, a small one called the micro-nucleus which divides and is handed on to the next generation during division of the paramecium and a macro-nucleus which is discarded at the same time. According to Dr Pelc's theory, the micro-nucleus contains the original genetic code, which is preserved intact for future generations while the macro-nucleus holds the working copies of the DNA which are used during an individual's life time and which accumulate the harmful errors of the ageing process.

It is possible to work out the sort of rate at which damage would cause errors to accumulate in the DNA copies postulated by Pelc and to compare this with the rate of the onset of senility as observed in whole animals and single cells. The theory is the best put forward so far to relate the genetics code to the ageing process, Dr. Pelc sees no immediate prospect of finding means to arrest ageing But the fact that some descendants of single celled animals appear to be able to stop the ageing process for themselves, offers a possible clue as to how it is done.

Biologists Assess Threat to Coral Reefs

A committee of the Australian Academy of Science reports that although coral can be killed by many agents, insecticides such as DDT and dieldrin are not among the factors responsible for the increasing destruction of coral on many sections of Australia's Great Barrier Reef. These and other poisons in polluted rivers discharging in to coastal waters lapping the coral wonderland are diluted by the huge tidal movements across the reefs and do not reach toxic levels in the ocean waters.

However, the main interest of the scientific committee was the Crown-of-Thorns starfish. Evidence was presented at its hearings that destruction of coral by the starfish on the present scale had not occurred in living memory

Divers equipped with snorkel and scuba gear inspected underwater damage and death of coral caused by the pest. Only a small proportion of the Great Barrier Reef, which extends over some 80,000 square miles of the continental shelf could be examined during the committee's survey.

Most of the reefs examined lay between Princess Charlotte Bay in the north and Palm Island to the south About 100 reefs were visited in the central area. Twenty-one reefs examined in the spring of 1969 showed evidence of serious destruction of coral. More than 90 per cent of the coral had been killed in 17 of 36 areas studied.

The committee made several recommendations The first was based on the conclusion that long-term and widespread control of the Crown-of-Thorns starfish is not the only destructive agent. Coral can be killed by many means These include cyclines, flooding from nearby mainland areas leading to dilution of reef waters, influx of silt too heavy to be removed by the normal motion of the coral cilia (waving hairs) and changes in water temperature.

In addition to the starfish, a number of other organisms are known to attack and kill coral. These include some sea slugs (nudibranch) burrowing sponges, algae, and *Culcita novaeguineae*

An interesting suggestion made by the committee was that cores should be taken from reef sediments to determine how numbers of the starfish have fluctuated from time to time in the past. This should indicate whether the current plague is a passing phase or whether it is symptomatic of a long-term ecological trend.

The eggs and larvae of the Crown-of-Thorns are attacked by coral itself, by certain reef animals, including a host of small, free-swimming species, but only one predator of the adult starfish has been found This is the Giant Triton (*Charonia tritonis*) which was formerly collected from the reefs in large numbers by visitors. The Academy Committee recommends that this predator should be declared a protected animal in Australian waters.

Dr. R Endean of the University of Queensland has proposed that the Giant Triton should be bred in large numbers for release at threatened sections of the Reefs. He also suggested that Tritons should be introduced from other areas, such as the Philippines, Taiwan, and Sabah to restock reefs depleted of this natural enemy of the starfish.

The starfish plague was first recognised in Australia about 1959. It has subsequently been reported as causing destruction of coral else where in the Pacific, including Guam, Truck, Rota, Johnston Island, the Palaus, New Guinea and Fiji Last year Australian marine biologists concerned with the Grown-of-Thorns problems conferred with 15 United States scientists on Guam to assess the problem and plan countermeasures.

Flame Sterilisation of Canned Foods

A new method of sterilisation by direct heating of cans in gas flames has been developed by Tarax Laboratories of Melbourne, Australia Commercial development followed research and pilot-scale tests by Mr. D J. Casimir of the Division of Food Preservation of CSIRO. The equipment is very compact and a unit with a throughput of 140 cans per minute occupies only 13ft x26ft. of floor space.

Foods such as soup, milk, and mushrooms can be processed more uniformly and at lower cost than by conventional methods based on steaming batch by batch in retorts. The flame methods is a continuous process in which the filled and sealed cans are conveyed continuously and under automatic control through the steriliser. They are sprayed with refrigerated water and discharged ready for packing in cartons

The compact, economical processing machine became practicable when the Melbourne engineers overcame early inequalities of heating by spinning the cans vigorously during their passage through the gas flames In practice, the direction of spin is reversed frequently to ensure maximum movement between the can and its

contents Spin is imparted to the cane by reciprocating bars under the conveyor

To ensure equal heating of the cans, automatic controls hold the gas energy input of the burners at a constant level, and vary the speed of the can conveyor in response to changes in heat requirements due to interruptions in can input or to changes in the heat balance of the tunnel as a whole

Commercial machines with outputs of up to 280 cans per minute to be manufactured by Anderson Equipment Co-operative Ltd , will be designed for a variety of heating fuels Present engineering limitations place a maximum of 3-inches on the diameter of cans processed by the method

Australian food preservation scientists believe that the new technique of flame sterilisation has a promising future, particularly in areas where cheap natural gas is available. Research is continuing in an effort to extend the technique to other food sterilisation situation.

Courtesy : Australian Information Service

Trace Elements and Animal Disease

DAVID DICKSON

Animals need a large number of mineral elements in their diet Some such as calcium and phosphorus, are used in forming the bones and teeth of the animal, and also play an important part in controlling the balance of chemicals in the body There are, however, other mineral elements that are needed only in extremely small quantities, but that are nevertheless equally important for maintaining health Since Only the minutest traces of these elements occur in an animal's body, they are referred to as trace elements, and during the last few years scientists have become increasingly aware of their importance in nutrition.

THE most important of the trace elements are copper, cobalt, manganese, zinc, iodine, molybdenum and selenium and despite their relative scarcity in the body each has its own vital role to play, the absence of any one frequently leading to serious illness and possibly death The trace elements are needed to help, the body produce many of the chemical substances it must have to function properly, bringing into action enzymes whose job it is to change one chemical into another A lack of copper, for example, can lead to a state of anaemia, since the body is no longer able to use the iron required in the production of red blood cells And molybdenum is necessary to activate xanthine oxidase, an enzyme which helps in the synthesis of uric acid during nucleic acid metabolism

Fig. 1.
An Aberdeen Angus calf showing symptoms associated with copper deficiency

Diseases in farm animals connected with trace element deficiency have been experienced by farmers throughout the world for many centuries, yet before the arrival of a scientific explanation, their incidence had been a mystery and had been ascribed to a variety of causes from the ingestion of toxic plants to mystical curses on certain areas of land It is now known, however, that an animal must take in its trace element requirement with the food it consumes. As animals cannot sense whether these

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trace elements are present or not, those put out to graze in areas where there is a deficiency of one or other of the elements in the soil begin to show symptoms of disease which reflect the deficiency Unless the animals are moved to some other unaffected area, or the deficiency made up by chemical compounds, a farmer can experience severe losses in his stock without fully realising what is happening.

Copper is a trace element lacking from many soils in various parts of the world. The first real evidence of the importance that it plays in an animals diet discovered by two research workers in Australia in 1937. They found that enzootic anaemia a disease that affects the nervous system in young lambs and leads to paralysis in the muscles of the back legs could be prevented by giving copper to the ewes during pregnancy Further more, they found that by giving copper to the lambs soon after they were born, they were able to halt the progress of the "delaye" form of the disease which can occur in lambs up to six months after birth.

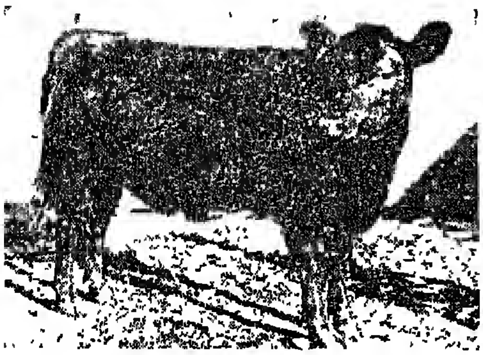


Fig. 2.

The calf after treatment with copper sulphate There is a difference of about 100 lbs live weight 4 months after treatment

In Britain the disease is known as swayback and investigations have revealed it to be widespread Before prophylactic measures were introduced, the mortality in severely effected areas varied annually from 1 to 50 per cent of all lambs born Those which survive and are most severely affected are sometimes blind and unable to stand or walk, while others may be able to walk only with great difficulty The worst cases usually die shortly after birth, but the milder ones survive and, when bred from later, may produce normal lambs. As mothers of affected lambs remain apparently healthy and show no signs of disease, genetic defects would appear to be ruled out.

Copper deficiency in sheep can also affect the colour and texture of the wool and an early symptom is the wool becoming stringy and loosing its texture As soon as the deficiency is remedied, however, the wool returns to its normal condition

Cattle, too, are prone to certain diseases if they do not obtain enough copper in their diet The observation that "falling disease" was caused by copper deficiency was first made in Western Australia in 1940. The condition, which mainly affected dairy cattle, was characterised by the sudden death of the animal and was found to occur particularly when pasture was lush and rich Mortality in some regions could range from 5 to 40 per cent in any one herd, and death was usually put down to heart failure brought on by the direct or indirect effects of extreme copper deficiency Symptoms included anaemia a lack of red blood cells decreased production with a lack of fertility, and retarded growth and development of young stock.

Injecting copper preparations, supplying mineral mixtures containing copper or even drenching the animal in copper sulphate solution will deal with the situation. Drenching is particularly successful on pregnant

ewes. An alternative method widely used in Australia is the spraying of pasture with copper compounds, but this involves certain dangers, since it may lead to a build-up of copper in the animal's liver an effect particularly noticeable in sheep with eventual toxic effects.

In addition to direct copper deficiency, similar symptoms can be brought about by what is known as "conditioned" Copper deficiency. There are several elements that can interfere with the way in which the body makes use of its copper, one of the most important, being molybdenum Certain pastures in England, in particular in somerset and Gloucestershire, have been known for over a hundred years to be associated with a condition in cattle known as "teart" Cattle grazed on teart pastures seem to have symptoms of copper deficiency, even though the copper content of the soil is normal But the molybdenum levels in teart pasture have been found to be about 20 to 100 parts per million compared with 3 to 5 ppm in ordinary pastures, so it seems that in some way an excess of molybdenum restricts the animal's ability to utilize its copper Other elements known to affect the metabolism of copper include zinc and lead.

Cobalt deficiency is also associated with particular soils, and in many countries it occurs over large areas Like copper, *the first proof of the importance of cobalt* came from Australia, where it had been known for many years that sheep confined for more than a few months to certain coastal area invariably started to lose condition and waste away until they finally died The disease was referred to as Coast Disease and intensive investigation proved that it was mainly caused by a relative lack of cobalt in the local grasses although the situation was complicated by a secondary lack of copper

It was soon found that the disease could be completely prevented or overcome by providing animals with additional sources of copper and cobalt, although not with copper alone. Since then many wasting diseases in various parts of the world have been related to cobalt deficiency and means of correcting this slowly improved

The cobalt is not required by the animal itself, but is an integral part of the production process of vitamin B_{12}, an essential nutrient produced by small stomach When too little cobalt is ingested the population of these microorganisms is affected Some of them disappear, and others usually a relatively small proportion of the total flourish When this happens, the production of vitamin B_{12} drops sharply and the animal is able to satisfy its needs only by drawing on the store of the vitamin it has already accumulated in its body tissues.

Cobalt deficiency is essentially a wasting disease. It is seen most commonly in sheep and cattle and, less frequently, in goats. Moreover, lambs and calves are more susceptible than mature animals and it is by no means rare for the young to die while their parents appear to be perfectly healthy.

In Britain, the condition is known as "pine". Although vitamin B_{12} thereby will prevent its recurrence in ruminant animals, it is more convenient and cheaper *to supplement* the diet with cobalt allowing the micro-organisms in the animal to synthesise the vitamin for the host This can be done by spraying pastures with a cobalt solution, or by placing a cobalt bullet into the animal's reticulum and allowing it to dissolve slowly This latter method has the added advantage that any cobalt not used is excreted and so improves the cobalt concentration of the pasture.

Deficiencies in other trace elements can also lead to serious illness; for example,

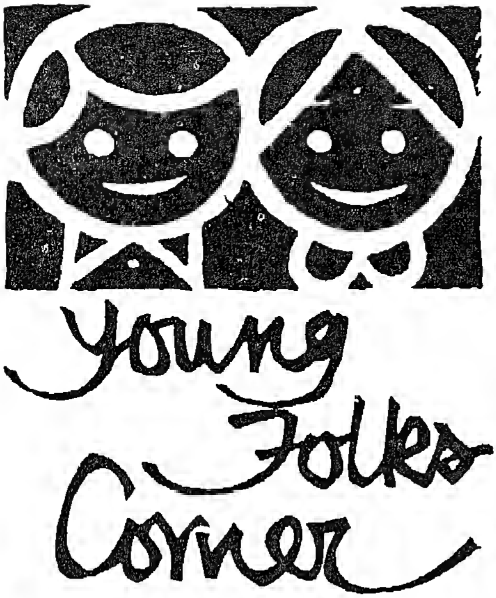
iodine. Although the amount of iodine present in an animal is very small usually less than 0.6 ppm, in an adult it is an extremely important constituent of the hormone thyroxine produced by the thyroid gland. Too little iodine in an animal's diet causes a decrease in the production of thyroxine, the main indication of this being an enlargement of the thyroid gland, a condition called goitre. As the thyroid gland is situated in the neck, the deficiency shows itself as a swelling, somethime referred to as "big neck". Reduced thyroid function also leads to reproductive failure and breeding animals with a shortage of iodine can give birth to hairless, weak or dead young

Where goitre is common, precautions are generally taken by adding iodine to food, usually in the form of an iodised salt, which contains the element either as sodium or potassium iodide or as sodium iodate The richest sources of iodine are those that come from the sea and values of up to 0.2 per cent iodine have been reported in some seaweeds, giving rise to the increasing use of seaweed preparations to remedy miner deficiency in the soil. Fish meal is also a rich source

Another element of interest is maganese, which is important to the animals body as an activator of certain enzyme reactions concerned with carbohydrate, protein and lipid metabolism. Manganese deficiency can lead to the discolouration of an animals' coat, to bone disorders and to infertility Fortunately, the condition is rare in animals kept undernatural conditions, although deficiency symptoms have been reported in young cattle grazing certain pasture on sand and peat soils in the Netherlands.

Zinc is an element which is found in small traces in every tissue in the human body and tends to accumulate in the bones rather than in the liver, which is the main storage organ of many of the other trace elements Deficiency is unlikely in grazing animals, since natural pastures usually contain enough zinc, but it can lead to a skin condition in pigs characterised by reddening of the skin condition in pigs characterised by reddening of the skin of the belly, followed by eruptions which develop into scabs

Finally, one element which has come under close attention in recent years is selenium It has long been known that the excess selenium which occurs in certain areas throughout the world can be highly toxic In the USA , for example, selenium is responsible for the disease known locally as "alkali disease" a chronic form of poisoning caused by the ingestion of certain species of plants which contain 10 to 30 ppm of selenium and "blind staggers". Recent work, however, has shown that a deficiency of selenium can also be dangerous, since it has been found to lead or contribute to both muscular dystrophy and white muscle disease. The exact role of selenium in preventing these diseases is unknown, but there seems now to be enough evidence to regard selenium as an essential trace element requiring further study.



For another ten years the word ECOLOGY would be used very commonly. Already it is being used in the western countries where the people have become very much aware of the environment and how it is getting polluted

It took nearly 3 5 billion years before man appeared on the stage of life on earth. Steadily by the application of knowledge he gained, he has renovated society and has now entered an era of science and technology This increased activity of man has necessitated accelerated exploitation of the natural resources both in quality and quantity Their collection and processing has led to a disturbance of the natural environment and balance in nature. Man is the only creature who has the ability to deliberately and massively alter the environment But quite often this disturbance acts against his own interests and against his very existence The normal balance in nature and consequently the guarantee that life will continue to exist on earth depends on man understanding the principles behind the wise use and management of natural resources

The science of biology in relation to the environment or ecology is a complex study demanding knowledge of several disciplines. It is necessary for us to influence the approach to the biological problems that surround us Every society has its difficulties with pollution, sewage disposal, the misuse of pesticides, neglect of parks, unnecessary deforestation and the population explosion. The great challenge to mankind is an appeal for proper education to solve these problems Man should be educated to maintain, the purity of his environment An ecological thinking is a basic feature of environmental education With this fact in view we have started a series of articles on environmental education and the fundamentals of ecology We have already published a few articles in our earlier issues of the journal and two more articles are published in this issue of *School Science* Contributions on this problem are solicited from knowledgeable persons who can give effective suggestions as to how environmental education could be imparted to the pupils at school and how the students can help in the programme of environmental preservation by their extra curricular activities

EDITOR

Nature—A City

C K. VARSHNEY
Department of Botany, University of Delhi, Delhi

A forest is more than a static body of trees. In many ways it is like a big city—

The City of Nature—inhabited by a wide variety of plants and animals, ranging from tiny microscopic organisms to giant animals such as tigers and elephants. There is a tough competition among the inhabitants of a forest, just as we find in our cities. All the available space is fully exploited by the occupants. The stratification of a forest into an upper storey consisting of very tall trees with spreading crowns, a second storey composed of trees with intermediate crowns; a lower storey of small trees; and a ground layer consisting of herbs and grasses. This vertical stratification is very similar to that in our cities which have multistoried, double-storied, and single storied buildings and then the pavement dwellings In a forest community there is a marked division of labour. All forest organisms are independent, yet each must rely on the other for food, shelter protection, and other essential services.

The science which deals with the study of natural communities is called *Ecology* The term has been derived by combining two Greek words *Oikos* (=house) and Logos (=study) In ecological terminology a living community such as a forest, is called an Ecosystem, which comprises both living and non-living components of the community. The non-living or abiotic components include nutrients, water, gases and physical factors like solar energy, wind, heat, etc. The living resources or the biotic components include an array of organisms. According to their activities the organisms in a community can be grouped broadly into producers, consumers, scavengers, and decomposers. All ecosystems, be it a pond, ocean, river, or a forest, maintain their structure and function by capturing the solar energy. The functional aspects described in the following paragraphs will show the interdependence of the members of a community

Green plants are the chief food producing organisms in a forest They provide food for all the members of the community. Green plants are endowed with the unique capacity of manufacturing food from common raw materials like water and carbon-dioxide by using the solar energy in the process of photosynthesis The end product of the combination of carbon dioxide and water is a simple sugar. It is from this simple sugar that all other substances which are known as food (carbohydrates, fats, and proteins) are made. Basically, what happens is that energy from the sun is trapped in food and released in the form of heat energy when this food is consumed and respired in the cells of living plants and animals. Vegetarian animals eat leaves, fruits, seeds, and other parts of plants. The herbivores convert the plant material into their body tissues and are eaten up by these carnivores. These, in turn, serve as food for bigger predatory animals of a forest.

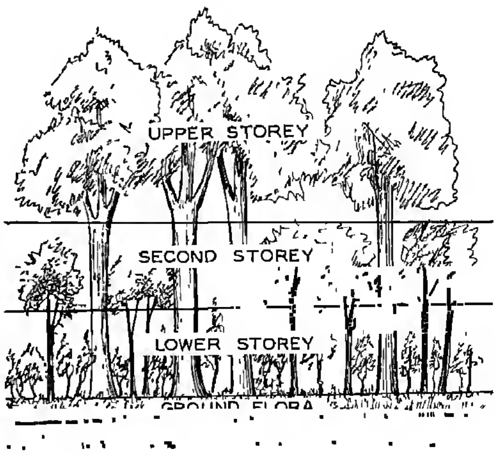


Fig 1
Multi-storeyed forest community

All members of a community are linked together by their eating and eaten relation-

ships, for example grass plants, which use sun's energy for manufacturing food, are eaten by a rabbit The food material in grass is digested and converted into the rabbit's body Rabbits are, in turn, eaten by the fox and a rabbit is digested by the fox in the same fashion as the grass was digested by the rabbit. The grass rabbit fox relationship is technically called a food chain In nature food-chains are seldom so simple. They are often branched and highly complex, for example a rabbit may eat many kinds of grasses and may be eaten by fox or any other carnivore In an ecosystem there are many such food-chains which are intermingled and interconnected at various points like the network of veins in leaves. The complex food relations in a community are referred to as a *food web*.

In an ecosystem all natural resources such as nutrients, water, and gases except energy, move in a cyclic fashion. Dead organisms and left-over materials in the society are promptly handled by scavengers and microorganisms which remain unnoticed in the soil. These organisms are busy round-the-clock in keeping the forest floor clean and hygienic. The microscopic bacteria and fungi quickly decompose the plant and animal debris and release the constituent mineral nutrients such as calcium, nitrogen, phosphorous, back to the oil for the use of

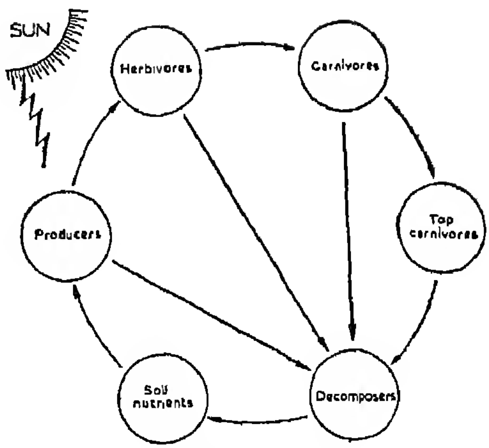


Fig 3.

A diagramatic representation of the dynamics of ecosystem.

the primary producers. These are the decomposers.

To a layman the producers, consumers including herbivores and carnivores) Scavengers, and decomposers, in a forest may appear as a haphazard congregation of individuals. But actually they form a highly organized community with coordinated and self-regulated activities

Forest animals are potentially capable of increasing more in numbers than the available food could sustain then. In a forest community, however, the population of each species is maintained within fair limits

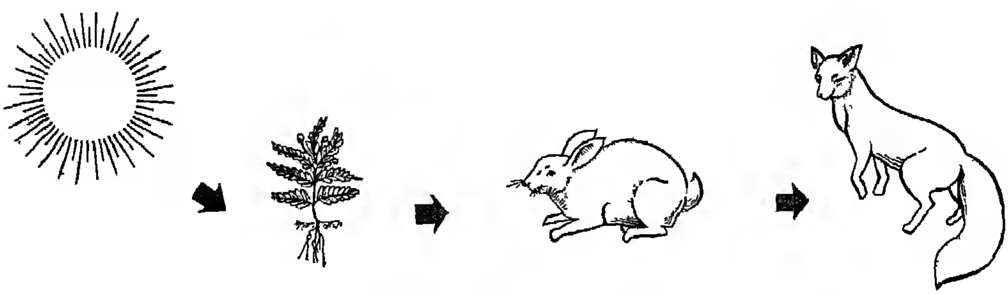


Fig. 2

A food chain

Plants too, have a high capacity to multiply Often enormous number of seeds are produced by each plant but only a few out of the whole crop get the favourable conditions to germinate and grow A large number of seedlings die away due to competition or they are nibbled away by hervivorous animals. Continuous search for food during day and night, unavoidable competition among the occupants for water, space, light, and for other environmental resources are the powerful forces in regulating the populations of various organisms at the desired level.

A forest if undisturbed will maintain its structure and stability with the help of built-in prey and predator relationship But man is changing these relations by harvesting economically important species of plants and animals in ever increasing numbers. Elimination or over exploitation of a particular species disturbs the natural balance in unpredictable manner The study of ecology is important to understand the community dynamics and for obtaining maximum sustained yields without over-straining the ecosystem.

Science Notes

Controlling Cretinism

RESULTS from clinical trials in the Western Highlands of Papua and New Guinea indicate that cretinism can be prevented by the administration of iodised oil The findings also confirm the theory that cretins are born as a consequence of severe iodine deficiency in the diet of expectant mothers during the first three months of pregnancy Professor Basil S Hetzel of the Department of Social and Preventive Medicine, Monash University Medical School, Alfred Hospital, Prahran, Victoria 3181, conducted the latest series of experiments aimed at relieving endemic goitre in New Guinea, where this condition is particularly severe

Earlier work by Australian doctors in the Public Health Department of the Territory of Papua and New Guinea had established that a single intramuscular injection of iodised oil will provide up to five years' protection against dietary insufficiency of iodine. Injection of iodised oil ('Lipidol') was first suggested by Dr *John Gunther*, a former Director of Public Health in New Guinea. Iodine deficiency is one of the commonest problems of human nutrition. It is primarily responsible for endemic goitre which affects over 200 million people throughout the world.

In most places the deficiency is corrected by adding iodine to the household salt supplies Elsewhere iodine tablets are distributed In Canberra and in Tasmania, as well as in several other communities around the globe, the bread supply is iodised. Each of these methods is cheap and can be highly effective. However, in many areas with indigenous populations, such as New Guinea, salt is not used in the diet. In others, such as Thailand, it has proved difficult to persuade the people to take salt other than that which they produce themselves from their own local earth, which is, of course, iodine deficient.

UNICEF has strongly supported the iodised salt method in northern Thailand, even putting dispensing machines on the railway stations, but generally the programme has been a failure in this region where almost four million people are involved. Similarly, the distribution of iodine tablets is difficult in isolated areas and the people may be careless about taking the weekly tablet Iodised bread is only possible in advanced communities where baking is industrialised and where the laws allow this technique to be used The whole question of the prevention of endemic cretinism, now possible through the use of iodised oil, is to be discussed next January at an International Symposium to be held at the Insti-

Courtesy : Australian Information Service.

tute of Human Biology, Goroka, New Guinea

The injection method has proved very suitable and effective in New Guinea where the rugged terrain and isolated communities make the regular distribution of any iodine supplement extremely difficult It is also reasonably cheap costing as little as 84 paisa for an adult dose which provides protection for at least five years. Many thousands of New Guineans have now been injected with iodised oil. So far no ill effects have been seen. The treatment not only prevents goitre, but also causes an established goitre to regress. This is so manifest that the people who have had little contact with Western medicine readily present themselves for injection. The disappearance of cretins from the villages has also been impressive. In one area comprising 16 villages 21 cretins were born among a total of 304 children over a three-year period before the treatment was introduced Subsequently, only one has appeared among the latest 317 children born in these villages since Professor Hetzel's team visited them

Eucalypt Crops for Wood Pulp

Eucalypts cropped on a six-year rotation could provide chip material for making wood pulp and paper, fibre board, and similar products. Forest products scientists of the Australian Commonwealth Scientific and Industrial Research Organisation recently reported results of preliminary experiments on the processing of coppice shoots from stumps of *Eucalyptus viminalis*. This species is widely distributed in south-eastern Australia and coppices freely.

There is increasing interest in many countries in the use of fast-growing trees as short-rotation crops based on intensive agricultural methods including the use of fertilisers, mechanical harvesting and handling and even irrigation

The prospects of increased world demand and of a possible shortage of wood for such purposes in future years have stimulated the search for cheap, continuing sources of chip material Growing forward commitments for export of chip from Australian native forests, particularly to Japan, have raised fear among some conservation authorities that unique forest areas may be destroyed by harvesting of mature timber for the chip trade. Cropping of regenerated coppice growth might well povide an economically and technically attractive source.

Experimental material was collected from volunteer coppice shoots of *E. viminalis* ranging from 2 to 27 years of age and from 1.6 cm to 31 8 cm in diameter

Assessments were made of the anatomical, physical, and some chemical properties of samples from steams of various ages and sizes As substantial economics would result if the bark did not have to be removed, the effect on the end products of inclusion of bark was examined in some detail. It was concluded that young bark could be a useful addition to the raw material, but that too high a proportion of older bark could have deleterious effects.

The possibility of pulping the entire tree shoot, including stem, branches twigs, and leaves was also examined Leaves had adverse effects on the product and the research team recommended that they be stripped, so that leaf comprises five per cent or less of the total dry matter processed. Twigs also presented difficulties, and should be removed with the leaves.

But provided the leaves and twigs were removed, coppice material up to eight years of

age, with an average butt diameter of about 7 cm was judged to provide a useful source of chip material for utilisation as pulp, paper and fibreboard Stem wood without bark, irrespective of age produced a light-coloured, shive-free pulp readily bleached for production of the fine paper. When bark was included, the pulp was darker, but still acceptable.

Pulps prepared from stem wood of *E viminalis* regrowth were equal in quality to those prepared from 12-year-old *E regnans*, one of the most highly regarded pulpwood species The paper-making quality of the pulp was not affected by retention of bark on the coppice stems, although the pulp was appreciably darker

More information is now required as to optimum spacing of coppiced trees, the economics of site preparation, desirable number of six to eight year rotations from the one root system, and other agronomic features relevent to commercial production. *E. viminalis* is a variable species and individual trees differ in heritable characters that effect coppice yields and certain characteristics of the pulp Selection within existing stands is thus another important aspect for future research.

Synthetic Green Pea Flavour

At the Food Preservation Laboratory, Delhi Road, North Ryde, New South Wales, the two chemicals mainly, if not entirely, responsible for the characteristic flavour of fresh green peas have been isolated, indentified, and synthesised. They are 3-isopropyl-2 methoxypyrazine and 3-s-butyl-2 methoxypyrazine. The possibility of using these chemicals to improve the flavour of canned and frozen peas is now being investigated

To find the chemicals the laboratory extracted the volatile components from one ton (roughly one million grammes) of fresh peas. From this quantity of peas, one gramme of water-free essence containing several hundred compounds was obtained. This separation and indentification of each of these components could have been an arduous task involving the determination of the chemical structure of scores of compounds that did not, in fact, contribute to pea flavour.

However, the job was made easy simply by sniffing each component as it emerged from a gas chromatograph and assessing its probable significance In this way two chemicals were finally detected which smelled intensely like green peas.

Both were present in extremely minute amounts The original ton of peas yielded only one ten-millionth of a gramme of each of the flavoursome chemicals Because of the minute quantities available, Sydney University's high-resolution mass spectrometer was used for the analysis. From the information obtained with this equipment the structures of the two chemicals were deduced and experimental quantities of them have now been synthesised in the laboratory.

*"Science Fiction" in Agriculture**

"Science fiction" ideas which might become tomorrow's solid agricultural facts were outlined in a lecture by Professor Peter Wareing, of the University College of

*Reprinted from SPECTRUM, No. 76, 1970.

Wales, at Aberystwyth. He said that work that began with simple mathematical new frontiers studies of plant growth was now opening in the field of science and food production.

One radical approach to the culture of woody plants was that in fruit growing the tree should be got rid of as an unnecessarily large and cumbersome framework for bearing fruit The suggestion, said Professor Wareing, was that apples and pears should be grown by planting one-year "maiden" standards in dense spacing. These would fruit in the second year and then be scraped. The yield per acre might prove higher than the traditional system—and cost less.

One of the factors limiting productivity of various arable crops such as sugar beet and potatoes was that seasonal development of an adequate leaf canopy lagged behind the seasonal rise in solar radiation in the spring so that much of this radiation was not intercepted by the leaves but simply warmed up the bare soil If more rapid leaf growth could be obtained in the spring, crops would benefit considerably

Another development was the production of haploid—single chromosome—plants by regeneration from pollen in a sterile culture Regeneration of whole plants might occur from pollen grain and these plants were haploid By doubling the chromosome numbers of these plants, pure breeding lines might be obtained in a single step, saving several years consumed by the normal processes of self-pollination. This technique would offer several advantages, particularly to the tree breeder where the long-life cycle of the tree rendered normal breeding methods very slow.

Even more revolutionary developments might be possible in the future. Work in Belgium had suggested that when purified bacterial DNA—the acids which determine the genetic code—was supplied to higher plants through the roots, stem or embryo certain fractions of this DNA appear to have been taken up into the plant cells and incorporated in the nucleus. This opened up the possibility, said Professor Wareing, of directly modifying the plant genome Other work showed that it might also be possible to transfer a block of genetic information from blue-green algae capable of fixing nitrogen by photosynthesis to the chloroplasts of cereal crops, so that these could make direct use of atmospheric nitrogen.

"At the present time," said Professor Wareing, "these ideas seem to belong more to the realm of science fiction, but today's fiction has the habit of becoming tomorrow's fact."

Professor Wareing said the availability of effective, non-toxic growth regulators opened up a number of possibilities, including the pre-treatment of crop seed to delay germination in the field; to delay bud-break in fruit trees in the spring, reducing the risk of frost damage; prolonging the dormancy of potatoes in storage, keeping down hedges and lawns and restricting the flowering of pasture grasses.

*New Applications for Fluorine Compounds**

SYSTEMS for cooling the millions of tiny circuits that will be developed in the next few years and the prospects of new highly active drugs were both mentioned in a chemistry session. Both applications come from the expanding uses of compounds based on fluorine.

*Reprinted from SPECTRUM, No 76, 1970.

Dr. E H.P. Young, of ICI's Pharmaceutical Division, told the meeting that drugs containing flourine provoked much greater reaction in the body and could be made highly specific. "Molecular roulette" by which hydrogen atoms in a molecule are replaced by fluorine and their position moved about, was a favourite game for chemists, he said.

Fluorine compounds were extremly stable, were accepted without trouble by cells as if they contained hydrogen and were highly soluble in fat, so that they could move through the body easily.

Using them, ICI had produced the most efficient and widely-used anaesthetic in the world—fluothane.

At present, sulphonamides containing fluorine were being investigated They had drawbacks at present, but some showed great activity against epilepsy and the research could continue for more efficient, improved drugs.

Fluorocarbon liquids are being manufactured by Imperial Smelting Corporation in Britain These liquids, said Dr. A K. Barbour, of ICS do not corrode metals or plastics, they are non-toxic and non-flammable and have extremly good electrical properties.

So electronic equipment, which produce heat when working could be immersed in them to be kept cool These fluids have already been used in the ground stations for the Skynet military satellite communications system

They enable the ground station to be air transportable by reducing the size of the power transformer by 15 times and its weight by 10 times.

The fluids are being used to cool laser range finders mounted on Land Rovers. But their greatest use is likely to be in minute circuits of, for instance, future computers. Heat from these, though small, was concentrated into a tiny area

Research programmes using the fluorocarbon fluids were showing very promising results.

New and More Powerful Atom Smashing Machine

THE British Government announced that it was prepared to cooperate with other members of the European Organisation for Nuclear Research in building a new and much more powerful machine for accelerating the nuclei of hydrogen atoms—otherwise known as protons—to speeds approaching that of light.

The stated energy of the new machine is 300,000 million electron volts—very much greater than that of the Organisation's present machine at Meyrin, near Geneva, where the Centre for European Nuclear Research (CENR) is situated. The new one is to be built near by.

Research in Britain at the Rutherford High Energy Laboratory has made new low-temperature techniques possible that may eventually raise the energy of the proposed machine to 800,000 million electron volts. The new machine would then be the most powerful accelerator in the world outside the Soviet Union

The proposed machine is called a proton synchrotron Such atom-smashing machines are used to accelerate the fundamental particles of matter to enormous speeds.

Only with these immense devices—the proposed one will be underground—can experiments of interaction between particles be done with the energies necessary to

imitate what happens in a nature when particles in the nucleus of an atom interact.

Such investigations started with the simple one called a cyclotron 40 years ago, and the power and size needed has been increasing ever since as physicists probe further and further into the fundamental nature of the atom and, therefore, of all matter. It is the last frontier of physics still to be reached

Courtesy: British Information Services.

No Exhaust Smoke from Production Concordes

LONDON, September 23—first tests with the engines that will be used in production Concorde jetliners have shown that they will produce no exhaust smoke—just a heat haze.

Rolls-Royce Ltd. said the Olympus jet engines in the Concorde prototype were currently producing black smoke because they were not fitted with the exhaust control system planned for the production aircraft.

Development of the Olympus is progressing so well that the Mark 602 engines to be fitted in the first production aircraft will be more advanced than those originally planned. This means that the supersonic jetliner will be smoke-free from the start of its service life.

The Mark 602 engines, which are now undergoing bench-testing following a first run at the end of last year, feature a new type of annular combustion chamber and low-pressure compressor which eliminate smoke without the use of fuel additives. It also further improves the engine's impressive reliability and ease of maintenance.

Thirteen engines of 602 standard will be involved in a development programme aimed at giving this type of engine some 9,000 hours of flight-testing before it goes into service.

Courtesy: British Information Services.

Satellite Tests May Improve Merchant Ship Communications

LONDON, September 11—better world-wide communications for merchant ships may result from space satellite tests to be made from a British container ship.

The ship, *Atlantic Causeway*, has been fitted with special aerials and equipment in order to act as a floating test-bed for satellite communications during the next six months. The experiments will be carried out while the vessel continues its regular commercial sailings between Britain and the United States

Atlantic Causeway will attempt various forms of communication with radio stations in Britain and America, and also with a Dutch ship, via a satellite controlled by the U.S National Aeronautics and Space Administration (NASA). Ship-to-shore and ship-to-ship telephone calls will go via the space satellite, as also computer data and radio-teleprinter and facsimile transmissions.

If successful, the tests will open the way to more reliable round-the-clock communications with ships in all parts of the world. The project could also lead to ships being linked to a shore-based computer, via a satellite, in order to obtain minute-by-

minute information on weather and docking situations.

The experiment has been sponsored by the British Post Office, and among others involved are the University of Swansea and the U.S. Coast Guard.

Courtesy. British Information Services.

New Laser to be Tested on Tissues and Cells

A team of scientists from the University of Hull (Northern England) hope soon to use the latest development in lasers for the selective destruction of tissues and cells. They expect to be the first to do so.

The idea for using the laser—of the tunable dye type from which many different wavelengths of radiation can be produced—has sprung from close co-operation between Prof S A. Ramsden of the Department of Applied Physics and Dr. M. Manning the Department of Zoology

"Recent developments in the field of tunable dye lasers make it possible to match the wavelength of a focussed laser beam to the absorption characteristics of tissue to be destroyed. The team is constructing such a laser."

Courtesy· British Information Services.

Indian Science Goes Abroad

IT is a matter of pride for us that for the first time the instructional materials developed by the Department of Science Education in the NCERT were exhibited at in another country where it received warm appreciation. The Government of the Union of Burma while celebrating the Youth Festival and the Unesco's International Education Year organized an International exhibition on Teaching Aids for Science Education. The Government of India was invited to participate at this international exhibition which was held in the middle of November 1970 at the ENVOY Hall, Rangoon. Besides India, 11 other countries of the world like the USSR, USA, German Democratic Republic, Japan, Federal Republic of Germany, Hungary, Czechoslovakia and Yugoslavia participated in this exhibition.

The Ministry of Education and Youth Services entrusted the task of participation to the National Council of Educational Research and Training which in turn asked the Department of Science Education to undertake this. Shri K.S. Bhandari who is incharge of the Instructional Material Centre of the Department was sent along with Shri R K Singh to organize and set up the exhibition at this international meet

The exhibition was formally opened by the Minister of Education of the Government of Burma on 22nd November, 1970. On this day besides the Minister the diplomatic envoys of all those countries which were participating in the exhibition visited the Indian stall.

Besides the Government officials of Burma from the Education Department and the ambassadors there were other prominent visitors. Teachers and students from nearly 400 educational institutions visited the Indian stall. The total number of daily visitors varied from 40,000 to 60,000.

Special Aspects of the Exhibition

The special aspect was the exhibition of science kits developed for the primary schools and the middle schools The kits were actually referred to by the visitors as mini-laboratories. In fact they were mini-laboratories in which several experiments could be set up and demonstration given by the officials of the team from Indiaa nd volunteers. These demonstration experiments attracted the attention of important visitors, science teachers, students and also the general public Simple items like balloons, glassbeads, demonstration spring balance, lead cylinder for molecular cohesion,students low cost microscope were all exhibited actually in the working condition. Some of the improvisations such as petrol gas plant, simple water analyser and students wooden stand chemical rectifier, students Kipp's apparatus, simple eudiometer tube, and kerosene burner created a great impression on the visitors who included educational administrators, science teachers and students of Burma. At the request of the authorities some special lectures for improvisation in Chemistry were arranged, by the leader of the Indian team, for science teachers and students of the University and Institute of Education

All the exhibits displayed in the Indian stall were handed over by the Indian Am-

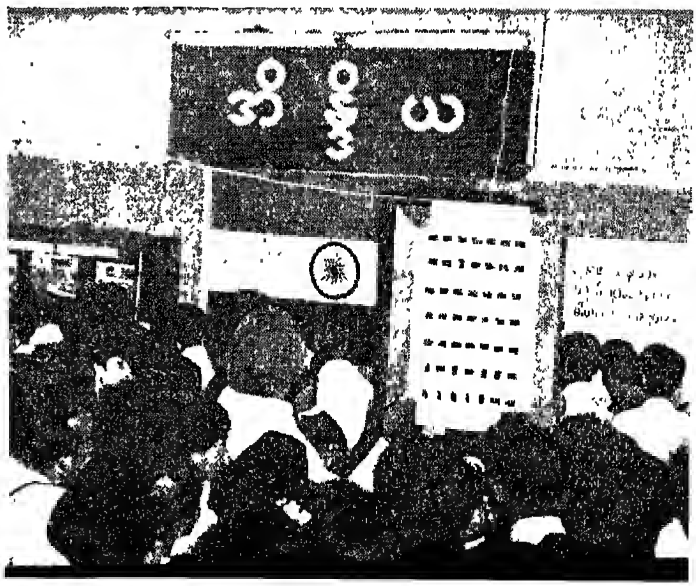
Indian Science Goes Abroad

Shri K.S. Bhandari, explaining the materials exhibited to Shri Baleshwar Parsad, Indian Ambassador in Burma when he visited the Indian stall.

A view of the visitors thronging at the Indian stall

Another view of the visitors going round the exhibits. The rush of the visitors may be observed.

Two views of the exhibits· One showing the science classroom pictures, and the second the slides of NCERT Project.



Some of the volunteers who helped in the running of the Indian stall, photographed along with the Indian Ambassador.

Indian Ambassador in Burma handing over NCERT materials exhibited to Dr Nyi Nyi Deputy Education Minister of Burma Dr. Nyi Nyi expressed the desire of Govt of Burma to adapt 75 to 90% science materials developed by the NCERT.

bassador in Rangoon to Dr. Nyi Nyi, Deputy Education Minister of Burma as a token of goodwill gesture from India to Burma.

The Deputy Education Minister while addressing the officials of the Government of India and Burma at the handing over ceremoney expressed the desire of the Government of Burma to adapt 75 to 90% of the science materials developed and prepared by the NCERT. In this aspect he requested generous cooperation and help from the Government of India. The Indian Ambassador in Burma, Shri Baleshwar Parsad while thanking the Government of Burma for its appreciation of the work done in India for improvement of science teaching assured him on behalf of Government of India that every possible cooperation and help would be extended to foster better understanding between the two countries and improve the quality of school education in our neighbouring country.

In order to explain the items on exhibits a special pamphlet about the Indian stall was prepared by the Indian team and this was translated into Burmese language. The pamphlets were widely used for distribution among visitors. At the request of the locol authorities some special lectures and demonstrations on science education and improvisation in chemistry were given by Shri K. S. Bhandari.

The general topics discussed during lectures and demonstrations were:

(a) Construction of improved school science curricula and problems of school science education.

(b) Modern methods and techniques of teaching science

(c) New methods of evaluating pupils' knowledge.

Science in Our Schools

Secondary School Science Teaching Project

Work on the main project of the development of curricular materials in all the science subjects and Mathematics for the high school stage continues. The first draft of the Physics textbook has been completed. Others are in various stages of preparation.

The final draft of Class IV textbook in General Science has been completed in English. It has been translated into Hindi and the two versions have been made press-worthy after editing in the Department. Over 160 illustrations have been specially designed for use in the textbook The draft of the teacher's guide has also been prepared.

The final drafts of the 2nd year textbooks for middle school stage in Physics, Chemistry and Biology which have to be supplied to the States, have all been completed and have been sent to the States for translation and adaptation. A new set of kit card for Physics Part I has been developed which illustrates the use of the kit for various experiments and gives guidance to the teachers as to how best to use the kits.

Study Groups

Physics Study Groups : The final draft of Book III to be used in the third year of the middle school was completed. The printing of Book II has been done in Calcutta. All the Directors of Physics Study Groups met at Nagpur on November 12, 1970. They finalised the programme for the next year and the group reported on the start of preparing text materials for the high school.

Chemistry Study Groups : Two inter-study group meetings were held at Poona and Chandigarh from 7th to 10th September, 1970. All the Directors of the Chemistry Study Groups met at Mysore from 13th October to 25th October, 1970. The Laboratory Manual and the text for Class X were discussed and revised. They had another meeting at Vallabh Vidyanagar from December 26 to 3rd January, 1971. There was an overall review of materials for Classes IX and X.

Biology Study Groups : All the Study Groups met at Madras from November 23 to 26, 1970, when the materials for Teachers Guide for Book IV, V and VI were finalized. During this period the book entitled "Non-Flowering Plants of the Himalaya" was brought out under the Supplementary Reading Materials Programme. The draft of the book "Medicinal Plants" was also finalized and was passed on to the Publication Unit for printing.

Mathematics Study Groups . All the Study Groups in Mathematics met from 7th to 9th September, 1970, at the Indian Institute of Technology, Kanpur. The programme for high school level was finalized. During the period under report Geometry Book III was printed at Bangalore Press and Mathematics Book IV was finalised. Teacher's Guide for Algebra Part II was also finalized and sent to the press for printing.

There was another meeting of all the groups at Jaipur from December 22 to 24, 1970, where the syllabus for Classss IX to XI was discussed and finalized. A few chapters for Class IX were also discussed It was decided to invite in February a few experts in Mathematics to review and offer comments on the syllabus and chapters

Training Programmes

The Department organized two orientation-cum-training programmes for key-personnel from different States. Each course was of 10 days duration where the participants were introduced to the approach and content of the curricular materials developed for the primary and middle stages. They were also familiarised with the kits and equipment for teaching science at the primary and middle school level The programme of Refresher Training to be organized by the States for teachers of the pilot project schools were also discussed and draft programmes prepared for these States. Nine key personnel from 5 States participated in these programmes.

Primary Science Project (UNESCO/ UNICEF assisted pilot project)

This project started functioning in 50 primary schools and 30 middle schools in most of the States from the academic session of 1970 These States have already been supplied the English versions of the text-book and illustrations for the teaching materials for first year's programmes. The Hindi speaking States were supplied with the Hindi versions of the materials. The total number of Hindi books supplied to the States till November 1970 is 46320, primary 18650, middle 27650. Each State has been supplied with the requisite number of Primary Science Kits and Physics and Biology Kits for the first year of the middle school classes The total number of kits supplied to the States so far is 1470, Primary 710, Middle School Physics and Biology Kits 760.

During this period a team consisting of the Head of the Department, representatives from the Unicef and Unicef experts attached to the Department visited the following States to assess the progress of the implementation of the pilot project and discuss various issues with the Education Secretaries, D.P.Is and Directors of State Institutes of Science Education.

Haryana
Panjab
Andhra Pradesh
Tamil Nadu
Mysore
Kerala
Pondicherry

National Science Talent Search Scheme

Arrangements for holding the examination for January 1971 were completed. This would be held in about 350 centres on 3rd January, 1971

Fifteen Science Talent Scholars from U.K and U S.A. visited India in the month of September 1970. A programme of get-together of these scholars with the NSTS awardees was orgnized. The foreign scholars were also taken on sight-seeing trips.

Seminars

UNESCO Regional Asian Seminar for leaders of Youth Science Activities: This Regional Seminar was held at Vigyan Bhawan from Monday 14th December, 1970 to 18th December, 1970. The seminar was under the auspices of I.C.C. with headquarters at Brussels, Belgium. There were 16 delegates representing 11 countries of Asia who attended this meeting. The UNESCO was represented by Dr. G.A. Teterin from Paris and I.C.C. by its Secretary General Mr. Francis Wattier. The meeting was inaugurated by Sri S. Chakravarti, Secretary, Ministry of Education and Youth Services. There were four sessions during which several papers from delegates were read and discussed.

These topics were:

1. The place and role of out-of-school youth science education within the text of the development of countries in Asia;
2. Out-of-school science activities for youth;
3. Science education for youth; and
4. Regional and international collaboration.

Certain draft resolutions to implement the foregoing main issues were also drafted and passed. This Asian Seminar was held just before the I.C.C. General Assembly which met from December 18 to 21, 1970.

The Department of Science Education was asked to convene this and Dr. M.C. Pant was the Liaison Officer Shri N.K. Sanyal, Shri S. Doraiswami, Dr. B. D. Atreya, Shri Ved Ratan participated in this seminar on behalf of the Department of Science Education.

International Co-ordination Committee for the presentation of Science and the Development of Out-of-school Science Activities—General Assembly

India played host to the General Assembly of the I.C.C. At the instance of the Ministry of Education, Dr. M.C Pant on behalf of the NCERT was the Liaison Officer for this General Assembly of I.C.C. Thirty delegates from 22 countries participated in this General Assembly. All the delegates who attended the Asian Regional Seminar stayed back to attend this General Assembly. The countries represented were Tunisia, Italy, India, Netherlands, Korea, Cambodia, Germany, Belgium, Hungary, Sweden, Canada, Argentina, Thailand, Israel, USSR Malayasia, Ceylon, Indonesia, UAR, Philippines and France. Besides the delegates there were several observers. The International Union for Conservation of Nature and Natural Resources was represented by Shri S. Doraiswami and Dr. V.M. Galushin both members of the permanent IUCN on Education. Several observers from NCERT also participated in this, namely Shri N.K. Sanyal, Dr. B.D. Atreya, Shri S.P. Sharma, Shri Ved Ratna. There were other observers from the Jagdish Bose National Science Talent Scheme, National Science Talent Search Scholars of the NCERT, Field Advisers from the Education Department of Delhi Administration. Prof. Ghosh of the Indian Association for Extra Curricular Science Activities was a delegate for India and he presided over working sessions.

Prof. V. K. R. V. Rao, Minister for Education and Youth Services, Government of India inaugurated the Assembly on 18th December, 1970. He stressed on the necessity of out-of-school science activities for all school children and not for only

those who look forward to a scientific or technological career.

Discussions

After fruitful discussions during fourth working sessions the General Assembly made some important recommenadtions. Some of these were :

1. An information service to provide members with most up-to-date data on extra-curricular activities.
2. An International Science Fair to be organized periodically by the I.C.C.
3. I.C.C. to organize training seminars for out-of-school science programmes.
4. Subsidies to promote students and teachers to attend out-of-school programme, conferences in other countries.

Other Activities

Production of New Equipment: Two demonstration kits were prepared as prototypes. With these kits a teacher will be able to demonstrate all the activities responsible for teaching of Chemistry and Biology in the middle school.

The Central Science Workshop has taken up a batch production of Physics and Biology Part II Kits and Chemistry Part I Kit for the middle schools. These will be supplied to the experimental schools under the pilot project in different States before the next school year 1971-72.

Preparation of Training Films: In collaboration with the Department of Teaching Aids two training films (i) New Approach to Primary Science Teaching and (ii) Teaching of Physics Part I for middle schools have been taken up Shooting on the first film has been completed and rush prints have been reviewed The script for the second film has been prepared.

Educational Literature: During the period ending December the following titles were produced·

(a) Textbook "Science is Doing" for class IV (cyclostyled)
(b) Kit cards for Physics Part I typed manuscript together with illustrations and photographs.
(c) Teacher's Guide for "Science is Doing" class III Hindi version.
(d) Revised syllabus primary general science
(e) School Science—the September issue has been published and the December issue is under print.

Central Science Workshop. On the sad demise of Shri T. R. Kapoor of the Central Science Workshop, Shri B.K. Sharma, has been appointed in that capacity. Shri B K. Sharma has now proceeded to USSR under the Unesco Fellowship Programme

OBITUARY

We are grieved to record that Shri T.R Kapoor, who had joined as the Technical Superintendent of the Central Science Workshop in September 1970, passed away in a tragic accident on October 1, 1970. We offer our heartfelt condolences to the bereaved family.

IN MEMORIUM

Professor C.V. Raman : Homage to an illustrious son of India and a creative genius

Professor Raman holding the model of a molecule of diamond

WITH the passing away of Professor Chandrasekhara Venkata Raman in the early hours of 21st November, 1970 at Bangalore, a great scientist of our times moved on into the pages of the history of modern science. In 1930, he put modern science in India on the International scene, being the first Asian Nobel Laureate of Physics. At the turn of this century Raman was only a student but he had started carrying out researches in the field of sound and optics and continued to do so until the last day when he was over 82 years old.

Young Raman had the distinction of being a 'first-ranker' throughout his educational career. Science was his first love right from the school days. He was richly endowed with an inquiring and a creative mind and all the great qualities of a real scientist.

Forced by circumstances Raman started his career in 1907 as a government officer Although the job was a very coveted one – that of Deputy Accountant General in the then Indian Financial Department, he found it a hindrance to his experimental researches With a spirit of self-sacrifice and his true love for scientific pursuits he soon decided to change over from this lucrative job to an academic assignment —university professorship—at the Calcutta University in 1917. It is here that his work culminated in the discovery which earned him a Nobel Prize The Royal Society of London awarded him a Fellowship in 1924. He was knighted by Emperor George V in 1930 for his achievements in science After doing fruitful work for 15 years Professor Raman shifted to Bangalore as Director of the Indian Institute of Science, and later on founded the Raman Institute.

On his voyage to Europe in 1921, while on the deck of a ship he wondered about the problem 'Why are the sky and the sea blue?' It is this initial thought that made him study thoroughly the scattering and diffusion phenomena of light in liquids, which ultimately led him to the discovery of the phenomenon called "Raman Effect'. This phenomenon deals with what happens to a beam of light of pure unmixed single colour (frequency) that enters a transparent substance. Much of it goes through without change. But a small part of the energy is lost by photons of the incoming light, the incident light scattered by the substance exhibits a change in colour. The change in colour which is characteristic of the substance involved, is a measure of the energy loss of photons is the gain of the molecules with which they come into contact while passing through the sub-

stance This provides a measure of the internal energy gained by the molecules Professor Raman worked with a rather simple apparatus but with a deep physical insight to discover this phenomenon The 'Raman Effect' paved the way for several important developments by providing a new technique for probing into the structure of substances. Thousands of research papers have been published by physicists and chemists using this technique Internal structure of tens of thousands of compounds have been investigated through this technique. During the thirtees, Raman's discovery developed into a new branch of optics—Raman's Spectroscopy This discovery has become a handy tool in chemical industry for examining chemical compounds

Professor Raman was a polymath, who ranged freely in the fields of physics and chemistry and in the later years entered even the realm of physiology. Hardly has a scientist touched as many branches of science as he did. In accoustics he developed a new theory about musical instruments. In optics he developed altogether a new branch—the 'Raman Spectroscopy', and in physiology new theories of vision and hearing He had a great love for diamonds not because of their market value but due to their challenging structure His studies of diamonds have been of great help in establishing the crystalline structure and for investigating the purity of diamonds.

Though many awards and honours came to Professor Raman, he attached little importance to them On the other hand he added to the honour of every title and honour bestowed on him. After independence, the Government of India conferred on him the distinetions of "National Research Professor " and "Bharat Ratna". He was honoured by Universities, National Science Academies and scientific organisations of numerous countries Besides this, several rare international distinctions were conferred on him, two of which may be mentioned. the International Lenin Prize (1957), Philadelphia Institute of America's Franklin Medal (1951) The medals and honours Raman had received in the past add up to an impressive array. In 1924 he founded the Indian Science Congress and helped it to have a firm footing. He was chairman of the Indian Academy of Science since its inception.

Professor Raman was great as a teacher and an orator. Many of his students· Prof K.S. Krishnan, F R.S., Dr. Vikram A Sarabhai, Dr. K.R Ramanathan, Prof. G.N. Ramachandran, Prof. R.S. Krishnan, Prof S Chandrasekhar, and Prof. N.S. Nagendra Nath, today hold top positions in the fields of scientific research and teaching. He was lucid and elear in his lectures and displayed a remarkable sense of humour The so-called 'generation gap' did not effect him-- he could easily express himself to school children on any scientific subjeet He was blessed with an ideal wife—Lady Lokasundari Raman. Not only she and other members of the family but the whole nation has been bereaved in the passing away of Bharat Ratna, Professor C. V Raman. He is missed by the students of science and those working in the numerous fields of science in India and abroad

To the budding seientists and those who lack guidance, his example of complete devotion and dedication will provide a great inspiration To pay homage to Professor Raman the Indian youth cannot do anything better than following the path led by him 'given the will and the effort one can achieve any height'.

K.J. KHURANA

Books For Your Science Library

The Research Papers Simplified (For High School and College Students),
Margaret R. Iverson

Prentice Hall of India, Pvt. Ltd. New Delhi, 1970 pp ix + 88. Price : Rs. 8 00

IN the modern science courses in schools the students are expected to take some project work on some simple science experiments or investigation of a problem. As a sequel to their findings they are expected to write a project report or a research paper. More often students are bewildered when they are asked to undertake a project or investigation and they lean heavily on the help of their teachers. Some students lack even the initiative for starting an experiment and they are all at sea with regard to the framing of their written paper. Of course, there are some exceptions to this situation where students are able to design their own investigation and write the papers. But very often this does not conform to the usual format. In such a situation the publication of a book of the type *The Research Papers Simplified (for High School and College Students)* by Margaret R. Iverson is to be welcomed. In this book the author has explained, step by step, the research techniques that are usually adopted by pupils. The language used in this book is very clear and simple

The first Chapter is the introduction where details about the writing procedure and the format of giving footnotes and citing bibliography are given. Many students experience difficulty in following the correct methods with regard to these. Besides the first Chapter there are 7 more chapters.

The Second Chapter describes what is research and how to select a subject and collect materials for the same. Detailed instructions are given as to how to take notes, prepare bibliography cards for various resources like periodicals, newspapers; secondary sources like plays, poems etc. The Third Chapter deals with how to write your paper i.e. the composition of the research paper. The Fourth Chapter deals with the method of quotations and footnotes. Chapter 5 deals with the preparation of the final copy, giving details of pagination, the title page, table of contents, the main outline text and the nature of headings. Chapter 6 deals with the arrangement of bibliography and the correct method of preparing the same according to the most modern style manuals. Chapter 7 gives instructions on proof reading and corrections. The Eighth Chapter is a summary. Following these chapters there are useful appendices with sample title page, short table of con-

tents, rules for word division, transition word and phrases and simple bibliography with classified references.

The task of preparing a research paper "requires self-discipline in addition to thought to be expended. But the end-product a logical, scholarly and compact analysis of subject makes writing a research paper as specified experience." The handbook itself carries a bibliography of several style manuals and other books which have been referred to in writing this book.

In the scheme of National Science Talent Search conducted by the NCERT the contestants are expected to submit a project report on some investigatory problem they undertake in the school at the time of the examination. Most of these projects lack uniformity in presentation. Some of these reports are extraordinarily like research papers but these papers have been guided by some relatives of the contestants who perhaps are in research laboratories or similar institutions. Some are guided only by school teachers who are not conversant with the usual format and style. These give the reports in the form of essay. Their style is very textual This book will be found very useful to prospective examinees of the National Science Talent Scholarship Scheme. Only the book is not comprehensive enough to include methods of preparing research papers on science subjects. It does not also reflect the conditions in the Indian situation If the author pays a little attention to these aspects in the next revised edition of the book it would really be helpful to science students in Indian schools and colleges. With many projects for improvement of science teaching going on in the country, the appearance of such an edition would be timely and helpful. The author may take the help of a scientist with a flare for preparing such books. The price of the book is also a little excessive. Our students usually cannot spare this amount to buy a book to serve one purpose. Ways and means could be found to reduce the price. Otherwise the book is handy and well-produced, giving a lot of information and instruction in the preparation and writing of a research paper.

S. DORAISWAMI